Volkovyskaya, Evgenia (2017) Lexico-semantic processing in adult monolingual Russian and bilingual Russian (L1) - English (L2) Speakers. PhD thesis, Middlesex University. [Thesis]

Final accepted version (with author's formatting)

This version is available at: https://eprints.mdx.ac.uk/22968/

Lexico-Semantic Processing in Adult Monolingual Russian and Bilingual Russian (L1) - English (L2) Speakers

A thesis submitted to Middlesex University

in partial fulfilment of the requirements for the degree of Doctor of Philosophy

Evgenia Volkovyskaya (BSc. Hons, MSc. Health Psychology)

Department of Psychology

School of Science and Technology

Middlesex University

September 2017

Abstract

The aim of the research was to examine lexico-semantic processes in monolingual Russian and bilingual Russian (L1) – English (L2) speaking adults. This has been achieved via two main approaches: The classic semantic priming paradigm in naming tasks and free recall tasks which take into account the growing body of research on the Age of Acquisition (AoA) effects in semantic processing and organisation. The Russian orthography has a unique writing system which is a combination of Roman and Cyrillic alphabets. Semantic priming was of special interest because it provides an opportunity to manipulate the semantic associations between words and the orthographic characteristics of the Russian orthography in order to address two key questions that dominate bilingual research: i) how the two languages of a bilingual are organised or stored, that is, whether each language is stored in one or more locations in bilingual memory and ii) how the two languages are processed, i.e. what mental capacities are required to process each language. Moreover, a review of the literature showed that little work has been reported in Russian, therefore, there are currently no theoretical frameworks that explain Russian (L1) monolingual or Russian (L1)-English (L2) bilingual storage or processing.

The starting point was to establish the presence of semantic priming in Russian monolingual speakers. The findings of a significant priming effect in Experiment 1 were in line with the predictions and add to the large body of literature on priming. Experiments 2 and 3 examined within-language priming (L1-L1 and L2-L2 respectively) in Russian (L1)-English (L2) bilinguals and the results indicated that although the magnitude of the priming effect was similar, the Reaction Times (RTs) were nevertheless significantly faster under the L1-L1 condition. The evidence was taken as an indication that the two languages were activated automatically via semantic activation therefore contributing positively or

facilitating the semantic priming effect. Between-language priming was employed in Experiments 4 and 5 which again showed a similar magnitude for priming in L1 to L2 and L2 to L1 with significantly slower RTs in the latter.

Exploiting the unique properties of the Russian orthography, Experiments 6-9 manipulated Russian and English orthographies in creating orthographically unfamiliar primes and targets. One question which has preoccupied bilingual research is a) whether and b) the extent to which the interconnections between L1 and L2 are reliant upon the orthographic features of the bilinguals' orthographies. The main objective is to examine the extent to which between-language interference occurs not just at the semantic but also at the lexical-orthographical level of language processing. The collective results for Experiments 6-9 show a robust priming effect across conditions together with a main effect for target orthography but not for target language. However, the magnitude of semantic priming varied greatly between the experiments. In conclusion, it is suggested that degree of semantic representation between L1 and L2 appears to be dependent on whether words' orthographic representation was congruent or incongruent (novel) with the language. These findings will be further discussed within the visual word recognition literature.

Experiments 10 and 11 were conducted to examine the role of Age of Acquisition (AoA) in monolingual Russian and bilingual Russian (L1)-English (L2) speakers in a free recall task as AoA is assumed to reveal semantic organisation, memory and language processing. As there are no previous reports of AoA effects in Russian, Experiment 10 was undertaken with monolinguals in order to establish the existence of AoA effect in a free recall task of words and pictures. A significant AoA effect confirmed the universal nature of AoA. Bilingual Russian (L1)-English (L2) speakers were employed in Experiment 11 using the same methodology as in Experiment 10, i.e., free recall words or pictures in either L1 or L2.

Experiments 10-11 also examined list effects by using pure versus mixed blocks to present stimuli to determine whether participants employ different recall strategies depending whether they see pure or mixed lists. As predicted, the size of the AoA effect was smaller for L2 than L1 as almost all the participants reported learning English at the age of 8-9. For words, the results showed an effect between L1 and L2 with better recall in L1 but not for AoA and a significant interaction between language and AoA. For pictures there was also a main effect for L1/L2 as well as for AoA. One other finding was that type of list did not have an impact on recall. Overall, these findings are in line with the predictions that because L2 words enter into the bilinguals' lexicon later than L1, one cannot expect the same magnitude of AoA effect under these circumstances. Evidence from picture recall show a robust AoA effect since picture processing is assumed to be language independent.

To summarise, the main aim of the research programme was to examine two key issues in related to bilingual language processing and memory, that is, how the two languages of a bilingual is stored and how it is processed. Whilst the overall findings from the semantic priming experiments indicate to a shared conceptual store for L1 and L2, the results from the free recall experiments demonstrate that AoA is fundamental in the organisation of a bilinguals' memory for pictures and words in both L1 and L2.

.1 Acknowledgements

This PhD thesis would not be thinkable without the support of the kind people around me.

First and foremost, I would like to express sincere gratitude to my supervisors Prof. Ilhan Raman and Prof. Bahman Baluch for their tremendous support. I thank Prof. Raman wholeheartedly, not only for her generous unsurpassed expert help, but also for her great patience, dedication and enthusiasm. I am thoroughly grateful to Prof. Baluch for being a constant source of motivation, for his encouragement and precious guidance. I could not have imagined having a better supervision for my PhD.

I am highly indebted and thankful to all of my friends for their understanding, trust in me and personal support throughout writing this thesis and my life in general. Agnieszka, Anna, Balbir, Diana, Dilya and Zina, I deeply appreciate your friendship.

Also, I would like to express my gratitude to a very exceptional team: Kuzmich, Marcus, Woody and Pasha, who made this journey special.

Finally, but by no means least, I am forever grateful to my Dad without whom I would not have chosen this path. You will always be missed and deeply loved.

Words can never be enough to thank my Mum and Grandma. Your love, care and almost unbelievable support inspire me to strive towards my goals and this thesis is dedicated to you.

Contents

Abstract 2

Acknowledgements 5

Contents 6

Figures and Tables 9

1.Chapter 1: Synopsis 10

1Preface 10

2Chapter 2 10

1.2Chapter 4 13

1.3Chapter 5 15

1.4Chapter 6 16

1.5Chapter 7 22

1.6Chapter 8 25

2.Chapter 2: Understanding Bilingualism 27

2.2Definition and classification of bilingualism 27

2.3Early empirical investigations and theoretical models of bilingualism 30

2.4Factors affecting bilingual language processing 33

3.Chapter 3: A review of theoretical frameworks in monolingual and bilingual lexical and semantic processing 36

3Preface 36

4Models of Visual Word Recognition 37

5Semantic networks 43

6Common versus separate stores models 45

7Word association versus concept mediation models 45

8The Bilingual Interactive Activation (BIA) and BIA+ models 47

9Revised Hierarchical Model 51

4.Chapter 4: A review of experimental paradigms employed in bilingual research 54

1.1Preface 54

10 Stroop Task in Bilingual Research 54

11Lexical Decision versus Naming tasks 56

12Semantic Priming Paradigm 59

12.1Types of Priming 61

12.2Mechanisms Involved in Priming: Automatic versus Attentional processes 64

12.3Within versus Between-language Semantic Priming 66

12.4Masked versus Visible Semantic Priming 71
12.5L2 Proficiency and Other Variables in Semantic Priming Experiments 76
12.6Psycholinguistic variables: Word Frequency and Length 77
12.7Stimulus Onset Asynchrony (SOA) 77
12.8The role of orthography in bilingual research: Orthographic manipulation of L1 and L2 80
13Context or List Effects: Strategic control in Experimental Blocks 83
14Free recall task 85
5.Chapter 5: Russian Orthography and its Importance in Psycholinguistic Research 88
15Preface 88
16A Brief History of the Russian Orthography 88
17Psycholinguistic Characteristics and Research on Russian 92
6.Semantic Priming in Monolingual Russian Speakers and Bilingual Russian (L1) - English (L2) Speakers in a Single Word Naming Task 1 98
18Preface 98
19A Methodological Concern: Masked versus Visible Semantic Priming 98
20Within-language semantic priming in monolingual Russian speakers and bilingual Russian (L1)-English (L2) speakers: Experiments 1, 2 and 3 100
21The Rationale 100
22Between-language semantic priming in bilingual Russian(L1) - English(L2) speakers: Experiments 4 and 5 112
23Semantic Priming in Orthographic L1 and L2 Manipulations: Experiments 6 - 9 118
7.Chapter 7: Age of Acquisition (AoA) effect in monolingual Russian speakers and bilingual Russian (L1)- English (L2) speakers in a free recall task 125
24Preface 125
25A Review of the Literature on AoA 126
26Theoretical Accounts of AoA 127
27AoA in experimental tasks 132
28AoA and Memory 137
29Experiment 10: The role of AoA on monolingual Russian speakers in a free recall task 140
30Experiment 11: The role of AoA effect in bilingual Russian (L1)- English (L2) speakers in a free recall task 143
8.Chapter 8: General Discussion 150
31Preface 150
32Searching for lexico-semantic processes and the role of AoA on free recall in monolingual Russian speakers 150
33How are the two languages of a bilingual organised? 161

34Is bilingual memory organised according to AoA? 165
35Conclusion 166
36Future Directions 167
References 171
Appendices 202

.2 Figures and Tables

Figure 1: Dual-Route Model of Oral Naming (adapted from Besner, 1999)..43

Figure 2: An example of a semantic network for 'DRINK' adapted from Andrews, Vigliocco, and Vinson (2009)..44

Figure 3: Word association model adapted from Potter et al. (1984) 47

Figure 4: Concept mediation model adapted from Potter et al. (1984) 47

Figure 5: The Bilingual Interactive Activation model (van Heuven et al., 1998)..................................52

Figure 6: The Bilingual Interactive Activation Plus model (Dijkstra and Van Heuven, 2002)................53

Figure 7: The RHM adapted from Kroll and Stewart (1994) 54

Figure 8: Naming RTs under related and unrelated conditions for Russian (L1) - English (L2) bilinguals in Experiments 2 and 3..114

Table 1: Russian (Cyrillic) Alphabet 91

Table 2: Phonological and Orthographical Representation of Cyrillic Alphabet 95

Table 3: Summary of experimental design for Experiments 1-3 102

Table 4: Descriptive statistics showing naming RTs in milliseconds and SD in related and unrelated prime-target conditions in Experiment 1 for Russian monolinguals 106

Table 5: Descriptive statistics showing naming RTs in milliseconds and SD in related and unrelated Russian prime-target conditions in Experiment 2 for Russian (L1) - English (L2) bilinguals 111

Table 6: Descriptive statistics showing naming RTs in milliseconds and SD in related and unrelated English prime-target conditions in Experiment 3 for Russian (L1) - English (L2) bilinguals 113

Table 7: Summary of experimental design for Experiments 4 and 5 117

Table 8: Descriptive statistics showing naming RTs in milliseconds and SD in related and unrelated prime-target conditions in Experiment 4..120

Table 9: Descriptive statistics showing naming RTs in milliseconds and SD in related and unrelated prime-target conditions in Experiment 5..121

Table 10: Experimental design and descriptive statistics showing naming RTs in milliseconds and SD (in brackets) under related and unrelated prime-target conditions in Experiments 6 and 7 using Russian orthography (L1) 125

Table 11: Experimental design and descriptive statistics showing naming RTs in milliseconds and SD (in brackets) under related and unrelated prime-target conditions in Experiments 8 and 9 using English orthography (L2) 127

Table 12: Experiment 10: Mean (in number of recalled stimuli), their corresponding standard deviations (SD) and number of participants for free-recall task in monolingual Russian speakers under pure and mixed list types 146

Table 13: Experiment 11: Mean (in number of recalled stimuli) and their corresponding standard deviations (SD) and number of participants for free-recall task in Russian (L1) 150

Table 14: Experiment 11: Mean (in number of recalled stimuli), their corresponding standard deviations (SD) and number of participants for free-recall task in English (L2) 150

1. Chapter 1: Synopsis

Preface

The main objective of this Chapter is to provide an overview of the research programme undertaken and a review of current psycholinguistic theoretical and methodological perspectives in relation to bilingual language processing.

According to recent statistics almost half of the world is bilingual (An and Wang, 2013; Grenoble, 2012). Simply put, bilingualism is the ability to speak, read and write in two languages and could be defined as the use of two languages to communicate with others and varies greatly in proficiency and functionality among other linguistic aspects. Bilingualism also varies by the skill and level of fluency in each of the two languages (De Groot and Kroll, 2014). For the purpose of this research programme, native language (also referred to as first language; mother tongue; dominant language) will be referred to as L1 and second language (also referred to as non-native or non-dominant language) will be referred to as L2.

Chapter 2

The aim of Chapter 2 is to provide review of the definition of bilingualism from a historical and psycholinguistic perspective and the current theoretical explanations of the cognitive processes involved in bilingual language processing.

The study of bilingual language processing has been the topic of substantial interest amongst cognitive psychologists (Brysbaert, Van Dyck and Van de Poel, 1999; Desmet and Duyck, 2007; Dijkstra and Van Heuven, 2002). Some of the methods used include but are not limited to behavioural and imaging studies on how the two languages (L1, L2) are stored, organised and retrieved. In particular, two keys issues have been the subject of intensive investigation: First, issues related to structural organisation 1) How the two languages of a bilingual are organised or stored with further questions raised in relation to i) whether the two languages are stored in one or different memory stores and ii) whether it is possible for bilinguals to switch from one language to avoid cross-language interference. Second, issues related to processing 2) How the two languages are processed with questions raised to address what mental capacities are required to understand and respond to each language in a different modality, namely, written and/or spoken (Jared and Kroll, 2001).

A brief review of historical developments showed that early study of bilingualism began with case studies, such as Leopold (1953) who studied his daughter's acquisition of German (L1) and English (L2). Later research attempted to improve the methodology and control for factors such as socio-economic background and age (Peal and Lambert, 1962). In the last 40 years there has been an increase in the number of experimental psycholinguistic studies on bilingualism (see Desmet and Duyck, 2007, for a comprehensive review). Research has primarily focused on experimental paradigms which can provide evidence critical in understanding the workings of the bilingual mind in relation to the two key issues raised above (e.g., Kroll, Van Hell, Tokowiczn and Green, 2010; Jared and Kroll, 2001).

1.1 Chapter 3

The aim of Chapter 3 is to critically review the main theoretical frameworks that provide an explanation for bilingual lexical and semantic processing from a psycholinguistic perspective.

A major assumption of theories of language processing is that each word known by an individual has three different types of representation in long term memory named the mental lexicon: phonological (sound), orthographic (spelling) and semantic (meaning)

(Morton, 1969; 1980; Coltheart, 1978; Rastle and Coltheart, 1999). Each word in the mental lexicon is assumed to be associated with other related words and therefore coexist together in networks (e.g., Collins and Quillian, 1969; see Figure 2). According to a recent review by Brysbaert (2014), a distinction exists between two levels of word-related information, namely, a level of semantic representations and a level of lexical representations (e. g., Kroll and de Groot, 1997; Malt, Sloman, Gennari, Shi and Wang, 1999). Lexical and semantic processing involves the selection of the most highly activated representation or node within a network. In this respect, word associations can be translated into networks of nodes (memory) linked to each other. A particularly interesting idea of networks for the organisation of the long term memory system, such as the lexicon, is that nodes (memories) connecting to a particular piece of information can be used as cues to this information through the principle of activation spreading and automaticity (Collins and Loftus, 1975).

It is important to note that the proposal of one of the earlier theoretical accounts for bilingual language storage was based on word associations (Potter, So, Von Eckhardt and Feldman, 1984) in which L1 and L2 have separate representations (lexicons) for words, i.e. two stores, one for each language (See Figure 3). Potter et al (1984) also proposed the concept mediation model in which a direct link between the conceptual representations and lexical representations in L1 exist; L2 links to conceptual representations can only be established via L1 (see Figure 4). In a seminal paper, Kroll and Stewart’s (1994) Revised Hierarchical Model (RHM) integrated both accounts and proposed that links from L2 to conceptual representations are determined by the proficiency in L2 (see Figure 5). That is, in cases where L2 proficiency is similar to L1 proficiency, the model predicts direct links to be established from L2 to conceptual representations. These theoretical accounts will be reviewed in view of the aims of the current research, in particular, the impact of proficiency on semantic priming in Russian (L1) - English (L2) bilingual semantic processing.

1.2

1.3 Chapter 4

The aim of Chapter 4 is to provide a critical review of the experimental paradigms used in bilingual research, namely, the Stroop task, lexical decision, semantic priming and naming tasks. For the purpose of the Synopsis, a brief review of semantic priming which will be employed in Experiments 1 to 9 is reported below.

In a seminal paper Meyer and Schvaneveldt (1971) reported one of the most significant empirical findings in the history of word recognition research showing that in monolinguals recognition happens faster if a word to be recognised immediately follows a word that is related in meaning. For instance, the word 'DOCTOR' is recognised faster and more accurately when preceded by the related word 'NURSE' than an unrelated word, such as 'BUTTER'. In this experimental task the first word is labelled the 'prime' and the second word is labelled the 'target' while the phenomenon, i.e., the faster recognition of the target word preceded by a related prime, is called *semantic priming.* When the recognition of the target is speeded up by a semantically related prime *facilitation* is said to occur while *inhibition* is the opposite effect, i.e. when the prime slows down the identification of the target (Kiger and Glass, 1983). Chapter 4 will also report a critical review of different types of methodological manipulations used in semantic priming paradigm such as lexical decision, Stroop and naming tasks to highlight their weaknesses and strengths in bilingual research. In addition, different types of semantic priming will be evaluated.

Semantic priming paradigm has been widely used in bilingual research as a tool '*..to uncover the mental representation of more than one language in memory*' (Altarriba and Basnight-Brown, 2007, p1). The rationale is that semantic priming is assumed to provide a robust measure of automatic processing of language. According to Altarriba & Basnight-Brown (2007) '… *this paradigm has become one of the most important tools used to determine whether or not a bilingual's languages are somehow interconnected and the levels at which this interconnectivity occurs*'. Overall, the findings show evidence for between-language semantic priming when the target is in one language (either in L1 or L2) and the prime is in the other language (either in L2 or L1 respectively). Similar findings are also reported from other between-language semantic priming studies (e.g., Altarriba, 1992; Chen and Ng, 1989; Kroll and Curley, 1988). Theoretically this has been taken to indicate that semantically related words share the same conceptual representations across the bilinguals' two languages, therefore providing support for the RHM (Kroll and Stewart, 1994).

A methodological concern in experimental design was raised with respect to order of prime-target presentation, i.e. L1 prime followed by L2 target and L2 prime followed by L1 target. For example, in an English-Spanish experiment prime can be given in one language, e.g. "cat", followed by the target in Spanish, e.g. "perro" or "dog". Moreover, prime and target can be presented in opposite direction, e.g. "gato-dog", when "gato" is Spanish translation for English prime "cat". Insofar as the order of prime and target presentation is concerned in between-language experiments, for the purpose of simplicity and consistency, in this thesis the term one-way will be used to indicate if experimental conditions are either L1 prime followed by L2 target only or L2 prime followed by L1 target only; similarly, the term two-way will be used to indicate if primes and targets are presented both in L1 and L2, that is, L1/L2 prime followed by L2/L1 target respectively. When one considers other factors that may influence experimental outcomes, such as L2 proficiency and language dominance, it becomes clear that a two-way design is more desirable to ensure a more comprehensive account of the relationship between L1 and L2.

1.4 Chapter 5

Psycholinguistic research using the characteristics on the Russian language including its orthography, phonology and morphology is still in its infancy. The objective of Chapter 5 is to explore the uniqueness of the Russian orthography and its importance for psycholinguistic research. The uniqueness of the Russian orthography is rooted in the way the Cyrillic and the Roman alphabets are combined to represent spoken sounds of the Russian language. The combination of alphabets creates a rare opportunity to examine lexical and semantic processing in bilingual Russian (L1) – English (L2) speakers. This is because there are some shared and some distinct features between Russian and English orthographies that can be experimentally manipulated to address the main questions raised in this research programme, i.e. how the two languages are stored and how they are processed. However, a review of the literature to date showed that little work has been done to explain how one reads in Russian (Ceytlin, 2000; Kerek and Niemi, 2009a; Kerek and Niemi, 2009b; Tsaparina, Bonin and Méot, 2011) and no previous reports were found on semantic priming in either monolingual Russian (L1) speakers or in bilingual Russian (L1) – English (L2) speakers. In this respect, to the best knowledge of the researcher, currently there are no theoretical models that offer an explanation in view of the lexical and semantic processing in Russian (L1) monolinguals or Russian (L1) – English (L2) bilinguals.

Russian possesses a complex alphabetic writing system and is reported to require time to develop the mastery of reading and writing (Kerek and Niemi, 2009b). In this respect, the Russian writing system provides a unique medium to manipulate orthographic, semantic and phonological features to examine lexical and semantic processing in monolingual Russian and bilingual Russian (L1) - English (L2) speakers. It is envisaged that this research will make an important contribution to psycholinguistics from both a theoretical and a methodological perspective in both monolingual and bilingual language processing.

A close examination of the extant literature revealed that semantic processes involved in adult Russian-English speakers readers have not to this date been the subject of systematic investigation. Of particular interest are questions related to identifying the nature of processes and the organisational architecture of storing and accessing semantic information in Russian-English bilinguals using the semantic priming paradigm, described in detail under Chapter 4. The overall aim of Chapter 6 is to describe the rationale, method, design and results of monolingual and bilingual Experiments 1 to 9 and to evaluate the findings within the theoretical approaches reported under Chapter 3.

1.5 Chapter 6

Although one of the main objectives of the research programme is to examine between-language semantic priming in order to address the issue of whether a bilingual's languages are interconnected, recent advances suggest that adding within-language conditions to studies are crucial in the interpretation and understanding of the between-language findings (de Groot and Nas, 1991; see Altarriba and Basnight-Brown, 2007 for a review). In this respect, Brysbaert (2016) sums the related issues in the following quote '*The degree to which the bilingual memory is language dependent or independent has been a vexing issue in research on bilingualism since the very first explorations*'. According to Altarriba and Basnight-Brown (2007) manipulation of only between-language conditions presents '*only half of the picture'*. Hence, in order to realise the main research questions raised by this research programme, the starting point is firstly to establish semantic priming in monolingual Russian (L1) speakers, i.e. within-language priming, in Experiment 1. This is also important in adding to the current literature because to the best knowledge of the researcher, there are no empirical reports of semantic priming in Russian in single word naming. In Experiment 1, 20 monolingual native Russian (L1) speaking university students were recruited from St-Petersburg State Paediatric Medical University, Russia and were asked to name related and unrelated targets in a list consisting of 21 semantically related pairs [врач *doctor* - медсестра *nurse*] and [собака *dog* - кошка *cat*] and 21 unrelated pairs [врач *doctor* – кошка *cat*] using SuperLab (henceforth English translation for Russian words will be presented in *italics*). As predicted, the findings yield a significant priming effect in native monolingual Russian speakers hence adding to the large body of literature on semantic priming in different languages in a word naming task. Experiment 2 examined semantic priming under within-language conditions in bilingual Russian (L1) - English (L2) speakers. Participants were 20 bilingual Russian (L1) - English (L2) speaking university students recruited from Middlesex University, UK and were asked to name targets presented in Russian (L1) only. The list for bilinguals contained 42 trials, including 21 semantically related pairs in Russian [врач *doctor* - медсестра *nurse*] and unrelated pairs [врач *doctor* - кошка *cat*]. Similarly, Experiment 3 employed the same method where 20 bilingual Russian (L1) – English (L2) speaking university students were recruited from Middlesex University, UK and were asked to name targets presented in English (L2) only. The stimuli were 21 semantically related pairs in English (doctor-nurse; dog-cat); 21 unrelated pairs formed by re-pairing the stimuli in the related cases (doctor-cat; dog-nurse). The number of errors and naming RTs in both experiments were measured. Furthermore, objective proficiency measures in English (L2) were taken into account to ascertain the L2 fluency of the participants. The English language fluency of bilinguals was measured using the Schonell Reading Test (Schonell, 1971). Insofar as the literature is concerned and to the best knowledge of the researcher, this is the first report that utilises an objective proficiency test in bilingual Russian (L1) – English (L2) speakers.

Experiment 1 was a semantic priming naming experiment with monolingual Russian speakers. Results showed a significant semantic priming effect of 25ms. This finding is in line with the predictions of the semantic activation hypothesis and is reported in Russian for the first time. Similarly, Experiment 2 showed a significant semantic priming effect in both Russian (L1) and Experiment 3 in English (L2) for bilingual speakers. Noteworthy is that semantic priming effect was larger in Experiment 2 for Russian (L1) in comparison to Experiment 3 for English (L2). A further finding when results from Experiment 1 and 2 were analysed together was that semantic priming in Russian was significantly larger in bilinguals compared to monolinguals. Moreover, in Experiment 3, a significant correlation was found between-language fluency in English (L2) and semantic priming effect in Russian (L1) for bilingual speakers. To summarise, significant within-language semantic priming was found for monolingual Russian speakers in Experiment 1 and reliably replicated in Experiment 2 for bilingual Russian (L1) – English (L2) speakers in Russian (L1). In Experiment 2, the magnitude of this effect in Russian (L1) was larger for bilinguals and was taken as an indication that the two languages (target and non-target) were activated automatically via semantic activation therefore contributing positively or facilitating the semantic priming effect. The results of Experiment 3 also yielded a significant priming effect in English (L2) that was significantly associated with proficiency indicating that proficiency is a contributing factor to the activation of semantic networks in bilingual memory.

As highlighted previously, one of the main key issues in bilingual language processing is the extent to which semantic representation from one of the languages is shared with the other language. Experiments 2 and 3 were within-language semantic priming naming experiments which employed bilingual Russian (L1) – English (L2) participants; in Experiment 2 the prime-target language was Russian (L1) with an effect of 50ms and in Experiment 3 it was English (L2) with a priming effect of 46ms.

Armed with the findings from within-language experiments, the subsequent experiments turned the attention to examining between-language semantic priming in bilingual Russian (L1) – English (L2) speakers. As reported above, between-language priming is widely used to study how bilinguals' two languages are represented and organized (Van Assche, Duyck and Gollan, 2016). In order to address methodological shortcomings and as suggested in the literature, a two-way design was used in between-language experiments. A total of 20 native Russian speaking students from St-Petersburg State Paediatric Medical University, St. Petersburg, Russia, took part in Experiments 4 and 5. In Experiment 4, materials comprised of either 21 semantically related pairs [e.g. врач (doctor) - nurse] and or 21 unrelated pairs [врач (doctor) – cat] while in Experiment 5 prime was presented in L2 (English) and target in L1 (Russian). Experiments 4 and 5 replicated Experiments 2 and 3 using between-language semantic priming from L1 to L2 (22ms) and L2 to L1 (33ms) effects respectively. The data from Experiments 4 and 5 were collapsed and analysed using a 2x2 ANOVA. The findings show a significant main effect for semantic priming [$F(1, 17)=17.07$ $p< 0.001$] and a significant main effect for language [$F(1, 17)=7.63$ $p<0.01$] whereby naming target stimuli was significantly faster in L1 compared to L2 (11ms difference). There was no significant interaction between the factors. Most notable however is that the *magnitude* of semantic priming in Experiments 4 and 5 is different between L1-L2 (22ms) and L2-L1 (33ms) conditions. This finding is contradictory to those previously reported in this field. For example, in a lexical decision task Keatley and Gelder (1992) reported a priming effect of only 6ms in French prime (L1) – Dutch target (L2) and -2ms (unrelated condition was faster than the related condition) in Dutch prime (L2) – French target (L1) conditions. The findings from Experiments 4 and 5 are taken to support the claim that semantic representations are shared in bilingual memory and are activated by accessing L1 and L2 although the level of activation appears to be dependent on proficiency.

To summarise, presenting bilingual Russian (L1) – English (L2) participants with prime and target stimuli in their L1 and L2 in the *expected*, familiar orthography has thus far yielded significant priming effects. The findings are collectively in line with the predictions of the theoretical models and research conducted in other language pairs reported in the literature (for an overview, see Lemhöfer et al, 2008). One question however which has preoccupied the domain of bilingual research is a) whether and b) the extent to which the interconnections between L1 and L2 are reliant upon the orthographic features of the bilinguals' orthographies. Exploiting the unique properties of Russian orthography, a series of Experiments 6-9 were devised manipulating Russian and English orthographies in creating orthographically unfamiliar primes and targets. The main objective is to examine the extent to which between-language interference occurs not just at the semantic but also at the lexico-orthographic level of language processing. The rationale for these experiments is based on the distinctive characteristics of Russian orthography which uses both Cyrillic and Roman letters (see Table 1 for details). Evidence for interference between the orthographies will be taken to indicate ortho-semantic interactions between the two languages suggesting shared representations in a single lexicon, i.e. a single memory store.

Experimental conditions described below were designed to explore between-orthography (O1 Russian Cyrillic and O2 English Roman) interference in Russian (L1, O1) - English (L2, O2) bilinguals. In Experiment 6 participants were asked to name Russian target words when the prime was a related English word transcribed in Russian, e.g. брэд /bread/ - масло *butter* (henceforth transcribed words were presented between two forward slash signs e.g. /bread/) and Russian target words when the prime was presented as an unrelated English word transcribed in Russian, e.g. батер /butter/ - стол *table,* i.e. L2/O1 prime followed by L1/O1 target. In Experiment 7 participants were asked to name related English target words transcribed in Russian when the prime was a Russian word, e.g. врач *doctor* - нерс /nurse/ and unrelated English target words transcribed in Russian when the prime was a Russian word, e.g. медсестра *nurse* - кэт /cat/, i.e. L1/O1 prime followed by L2/O1 target. In Experiment 8, participants were asked to name related Russian target words transcribed in English when the prime was an English word, e.g. bread - maslo *butter* and unrelated Russian target words transcribed in English when the prime was an English word, e.g. chair - hleb *bread*, i.e. L2/O2 prime followed by L1/O2 target. In Experiment 9, participants were asked to name related English target words when the prime was a Russian word transcribed in English, e.g. koshka *cat* – dog and unrelated English target words when the prime was a Russian word transcribed in English, e.g. medsestra *nurse* - cat, i.e. L1/O2 prime followed by L2/O2.

The collective results for Experiments 6-9 show a robust priming effect across conditions [F (1, 152) =4.30 p<0.40] together with a main effect for target orthography [F (1, 152) =23.66 p<0.0001] but not for target language [F (1, 152) =0.93 p=0.34]. None of the interactions reached significance (p>0.05). However, the magnitude of semantic priming varied greatly between the experiments as follows: in Experiment 6, a 21ms priming effect was observed followed by a 1.4ms effect in Experiment 7; a 27ms in Experiment 8 and a 13ms in Experiment 9. The reasons underlying the disparity of the priming effect will be discussed in detail in Chapter 6 but for the purpose of Synopsis, it is suffice to conclude that degree the semantic representation from L1 is shared with L2 appears to be dependent on orthographic representation, a much researched aspect of visual word recognition literature which will be discussed in Chapters 3 and 4.

The series of Experiments 1-9 reported here attempted to shed light to this by examining semantic priming in adult native monolingual Russian speakers and Russian (L1) – English (L2) bilinguals under different experimental conditions. Based on the theoretical considerations introduced above, it can be concluded that Russian (L1) – English (L2) bilinguals develop automatic between-language links at the semantic level, as predicted by the Revised Hierarchical Model (Kroll & Stewart, 1994; and the BIA+ model).

1.6 Chapter 7

To further investigate bilingual memory, the subsequent experiments were conducted by employing a contemporary psycholinguistic variable, namely, Age of Acquisition (AoA) because AoA is assumed to reveal semantic organisation, memory and language processing where monolinguals are concerned (see Johnston and Barry, 2006 and Juhasz, 2005 for comprehensive reviews). The AoA effect has been widely reported in the literature as the processing advantage of early learnt items have over items learnt later in life where early items are typically named or recognised faster and more accurately than late items. In a sense, AoA could be considered to reflect the developmental architecture of semantic networks and memory which led to the proposition of the semantic hypothesis of AoA (Brysbaert, 2000). Brysbaert and colleagues (2000) argued that the age at which words are acquired could be an important organising factor of the semantic system, i.e. memory, '*The dependence of word meanings on previously acquired meanings and the highly interconnected nature of semantic concepts may be the main reason why the order of acquisition remains the most important organising factor of the semantic system throughout life*' (Brysbaert et al, 2000).

The semantic hypothesis assumes that the magnitude of AoA effect will be higher in tasks that require access to semantic level of language processing. The main assumption is that semantic processing will be faster and more accurate for early acquired words or items because they entered into the representational system first and later acquired words or items were built up upon them. Hence, early acquired words influence the way late acquired words are represented.

A review of the literature show that AoA was brought into attention as a psycholinguistic variable by Carroll and White (1973) who found that responses to pictures of objects learnt early in life were much faster than pictures of concepts that were learnt later and that AoA was the single most important predictor of object naming latencies. This finding had a significant impact on the theories of word and picture recognition in which behavioural data, such as RTs, was explained in terms of frequency (how common an item is) as the prominent psycholinguistic variable. Noteworthy is that AoA and frequency are correlated as most early acquired items are also of high frequency (more common) and late acquired items are of low frequency (less common). However, when the correlation between AoA and frequency was taken into account, it was repeatedly shown that frequency had no independent effect on object and word processing (e.g., Morrison, Ellis and Quinlan, 1992; Morrison and Ellis, 1995; Barry, Morrison and Ellis, 1997; Gilhooly and Logie, 1981; Brown and Watson, 1987; Coltheart, Laxon and Keating, 1988). Morrison and Ellis (1995) independently manipulated frequency and AoA and reported that only AoA had an influence on naming RTs of individually presented English words and that the word frequency effect was no longer apparent once age of acquisition was controlled for.

The focus of interest in Experiments 10 and 11 were on the questions of a) whether and b) how important the role of AoA is in monolingual and bilingual language organisation and memory. AoA effect has been reported in in tasks that require lexical and semantic processing, e.g. lexical decision task (Gerhand and Barry, 1999) and semantic categorisation tasks (Brysbaert, Van Wijnendaele and De Deyne, 2000). Although the AoA effect was originally reported in English (e.g., Carroll and White, 1973; Morrison & Ellis, 1995), studies from different languages such as Dutch (Brysbaert, Lange and Wijnendaele, 2000); Spanish

(Sanfeliù and Fernandez, 1996); French (Alario and Ferrand, 1999; Bonin, Chalard, Méot and Fayol, 2002); Turkish (Raman, 2006, 2011); Italian (Wilson, Ellis and Burani, 2012) and Chinese (Weekes, Shu, Hao, Liu and Tan, 2007) also report AoA effects.

Having established the link between semantic activation in semantic networks (Collins and Quillian, 1969) and the semantic hypothesis (Brysbaert et al, 2000) in relation to AoA, two further experiments were designed to test long-term episodic memory in free recall. In a partial replication of Raman, Raman E., Ikier et al (2015, under review), Experiment 10 is the first report the role of AoA on free recall in monolingual Russian speakers using pictures and picture names (words) taken from Tsaparina et al norms (2011). Moreover, the presentation of stimuli was manipulated in a pure versus mixed block design in order to control for list effects (see Lupker et al, 1997; Raman et al, 2004 for reviews). The results show a robust main effect for AoA effect in free recall irrespective of list type for words [F (1,19) =9.44 $p<0.006$)] and for pictures [F (1,19) =46.9 $p<0.0001$). None of the interactions reached statistical significance. To the best knowledge of the researcher, this is the first report of AoA effect in Russian in a free recall task for words and pictures. Experiment 11 was a replication of Experiment 10 but this time in Russian (L1) – English (L2) speakers who took part in the free recall task in both L1 and L2. For words, the results showed a reliable main effect for language [F (1,8) =49.58 $p<0.0001$] but not for AoA [$F<1$] and a significant interaction between-language and AoA [F (1,8) =14.40 $p<0.005$]. Post hoc tests showed that while early AoA words were significantly better recalled in Russian this was not the case for late AoA words. For pictures, there was also main effect for language [F (1,8) =86.30 $p<0.0001$] as well as for AoA [F (1,8) =28.60 $p<0.001$]; none of the interactions reached statistical significance. Overall, these findings are in line with the experimental hypotheses which predicted that because L2 words enter into the bilinguals' lexicon later than L1, one cannot expect the same magnitude of AoA effect under these circumstances.

Evidence from pictures show a robust AoA effect since picture processing is assumed to be language independent. These results are in line with the predictions of the semantic hypothesis (Brysbaert et al, 2000) and are taken to indicate the role of AoA in the ongoing construction of bilingual memory.

1.7 Chapter 8

The aim of Chapter 8 is to review the findings from the study within the theoretical frameworks. It will be discussed that the findings provide further evidence to the universality of semantic and lexical processes irrespective of type of orthography. Similarly, in line with the current literature, within (L1-L1 and L2-L2) and between-language (L1 <> L2) semantic priming experiments in bilingual Russian (L1) – English (L2) adults show how the magnitude of the priming effect is dependent on various factors such as L2 proficiency, context and orthographic familiarity.

To conclude, the main aim of the research programme was to examine two key issues in related to bilingual language processing and memory, that is, how the two languages of a bilingual is stored and how it is processed. Whilst the overall findings from the semantic priming experiments indicate to a shared conceptual store or semantic representations for L1 and L2, the results from the free recall experiments demonstrate that AoA is fundamental in the organisation of a bilinguals' memory for pictures and words in both L1 and L2.

2. Chapter 2: Understanding Bilingualism

'Bilingual is not two monolinguals in one person'

Grosjean (1989)

2.1 Preface

The aim of Chapter 2 is to provide a definition and a classification of bilingualism from a historical perspective prior to reviewing the literature on psycholinguistic studies of bilingual language processing. Also, for the purpose of this report a brief review of early empirical investigations of bilingualism will be provided followed by discussing the factors that can influence bilingual language processing. This Chapter aims to provide the reader with general information regarding features of bilingual language processing before further detailed accounts of psycholinguistic theories and investigations addressing lexico-semantic mechanisms in bilingual speakers.

2.2 Definition and classification of bilingualism

The ability to use spoken language to communicate with one another is a unique, inherent human characteristic that infants acquire without much effort. The additional ability to speak more than one language, i.e. *bilingualism*, because of contact with other communities, immigration and trade has been reported since Antique times dating back to the Sumerians (Woods, 2006). In this respect, a widely accepted definition of bilingualism is '*both regular use and communicative competence*' in L1 and L2 (Francis, 1999, p. 194). This very human behaviour has attracted much attention from philosophers to physicians throughout history and from psychologists in modern times.

From an evolutionary perspective, bilingualism can be perceived as a complex and a multifaceted process that involves the interaction of cultures, expression of social experience, and history of a particular people as well as the mechanism of interaction of languages (Roberts, 2013). Bilingualism makes contact with others possible, provides socialisation, forms tolerant attitude towards other cultures while it enhances cognitive abilities. At the same time it is a prerequisite for the formation and perception of ethnic and social identity (Shi, 2007).

One aspect that has preoccupied researchers in the area of bilingual studies is the difficulties faced by a comprehensive classification of bilingualism that accurately defines an individual's skills in different modalities such as literacy and speech, performance and proficiency on the two languages they speak. The most common perception of a bilingual is someone who is almost equally fluent in two languages or at least proficient enough in their L2.

Various classification systems have been offered to explain the variation in fluency, competence and order of acquisition for bilingual language use. For example, the degree of knowledge of languages has been labelled as either subordinate (when bilingual speaks one language better than the other) and coordinate (or "pure", when a person speaks two languages in equal measure) (Grosjean, 1997). In addition, bilingualism has been described according to frequency of usage as either active (where both languages are used on a regular basis) and passive (the frequency of the use of one language dominates the other). The degree of proficiency of the second language has also been used to classify bilinguals as receptive, reproductive or productive where receptive bilingualism is defined as the ability to understand the subject of a non-native language (L2). Reproductive bilingualism involves the ability to competently reproduce spoken language in L2 and productive bilingualism is the ability to competently express thoughts and speech in L1 and L2 (Grosjean, 1997).

According to Bialystok and Hakuta (1994) a further definition of bilingualism depends on when L2 was acquired in relation to L1 leading to: 1) Simultaneous bilingualism when L1 and L2 were acquired in the same time (from speaking no languages directly to speaking two languages) 2) Early sequential bilingualism - L2 was learnt later than L1 in early childhood. Early sequential bilingualism is a large growing group of speakers world-wide. 3) Late bilingualism - L2 was acquired in adolescence or later. For the purpose of the thesis, this classification will be taken to describe bilingualism.

One further aspect of bilingualism that has preoccupied researchers is the proficiency with which a bilingual speaks their second language (L2). This is because L2 proficiency could range from very basic communication to L1 level fluency; hence, it is a very important factor to control for in bilingual studies. Also, bilingualism can be classified by levels of proficiency on production and reception (comprehension) (Bialystock, 2001). Productive bilinguals can speak and understand L2. Receptive bilinguals can understand both languages, but their abilities to produce L2 are limited. A main objective of the current research is to understand semantic and lexical processes in bilingual Russian (L1) - English (L2) speakers in view of their L2 proficiency by using an objective measure, namely the Schonell Reading Test (Schonell, 1971) which will be described in detail in Chapter 5.

However, it is difficult to find clear types of bilinguals, but rather a combination of types, which depends on particular features of language acquisition. Grosjean (1997) considers that the bilingual mind is not a simple combination of two monolingual language models, but a unique communication system that can use both languages or switch from one language to another depending on a subject and situation and that bilinguals differ from monolinguals in terms of language perception and production.

For the purpose of this Chapter, a review of early psychological investigations of bilingualism will be provided next.

2.3 Early empirical investigations and theoretical models of bilingualism

In this part of the Chapter, the discussion is returning to two key issues that have been of particular interest from a psycholinguistic perspective in bilingual studies, namely, how are two languages organised and stored? And how are they processed in the bilingual mind? Although theoretical accounts of bilingualism will be discussed in Chapter 3 in detail, the following is a brief summary with reference to two positions, namely the common store (Paivio et al, 1988) and separate store models (Potter, So, von Eckardt and Feldman, 1984; Scarborough, Gerard and Cortese, 1984). Separate-store model suggests that there are two mental lexicons or dictionaries, separate for each language and a bilingual speaker can switch from one language to another avoiding between-language facilitation (Potter, So, von Eckardt and Feldman, 1984). Separate store models are supported by findings from repetition priming tasks where facilitation is bigger in within-language than between-language conditions (Kirsner, Smith, Lockhart, King and Jain, 1984). According to the common store model there is only one lexicon where words of both languages have direct access to the semantic memory system (Scarborough, Gerard and Cortese, 1984). This model is supported by the fact that a psycholinguistic phenomenon (semantic priming, discussed in Chapter 3) produces facilitation not only within but also between languages (see Altariba and Mathis, 1997 for a review). However, it is possible that a mixture of common and separate stores is in use (Taylor and Taylor, 1990).

Early studies on bilingualism were case studies as reported by Leopold (1953). Peal and Lambert (1962) are often cited to follow up Leopold (1953) exploring the experience of 10-year old bilingual English (L1)-French (L2) children and its influence on intellectual functioning. Peal and Lambert (1962) employed 10-year old children monolingual French and French (L1) – English (L2) from six French schools in Montreal. Verbal and nonverbal intelligence tests were successfully administered in both French and English. Testing was divided in 5 stages 1 hour each, speced about a week apart. Instructions for tests in French was presented by native French speakers, English language test were presented by native English speakers. The results of the study supported the hypothesis that bilinguals employ a set of diverse mental abilities to administer verbal and non-verbal intellectual tests more successfully than monolingual speakers. Bilingual speakers performed significantly better than monolinguals. On both verbal and non-verbal intelligence tests.

Later on, focus switched from case studies (e.g. Behne, 1994; Leopold, 1953) to psycholinguistic experimental methods of language processing. Different methods were employed in order to find out how the bilingual mind organises and stores two languages, and how it differs from monolingual language storing and processing.

Further studies aimed to investigate external factors such as parents' use of language and its influence on early bilingual performance of their children (De Houwer, 1999). Those children whose parents deliberately chose to speak both languages (L1 and L2) were able to switch from one language to another faster and more efficiently than children who acquired second language later because their parents spoke mostly in one language (De Houwer, 1999).

In this respect, the Stroop task has been historically a popular research tool employed to study monolingual (e.g. Boyden and Gilpin, 1978; Cohen, Dunbar and McClelland 1990; Warren and Marsh, 1978) and bilingual language processing (Costa, Albareda and Santesteban, 2008; Dyer, 1971; Goldfarb and Tzelgov, 2007; Preston and Lambert, 1969; Zied et al., 2004). The Stroop effect (Stroop, 1935) refers to the phenomenon that when reading aloud colour words participants take longer if the colour word to be read is printed in a different or incongruent colour condition (for example, the word **RED** written in blue ink) than when it is in a congruent or same colour (e.g. **RED**) condition. The results of the classical Stroop experiment showed longer reaction time for the incongruent condition compared to the congruent condition. In monolingual Stroop experiments the stimulus and the response were given in the same language. Bilingual Stroop task represents between-language manipulation between the congruency of the trials given in different languages (Dyer, 1971; Preston and Lambert, 1969). For example in Spanish (L1)-Catalan (L2) studies participants saw the word **BLAU** (blue) written in red ink, and had to name the following Spanish word **ROJO** (red) (Costa, Albareda and Santesteban, 2008). Similar experiments in different language pairs showed that within-language Stroop effect was larger than between-language reaction time (Bril and Green, 2013; MacLeod, 1991; Marian et al, 2013; Roelofs, 2009; Rosselli et al, 2002; Sumiya and Healy, 2004). This difference in reaction time between within-language and between-language was attributed to language activation in non-target language (Green, 1998). Within-language interference is influenced by L2 fluency and whether writing system (alphabetic, logographic or syllabic) is shared between-languages (van Heuven et al., 2011). However, as reported by MacNevin and Besner (2002) Stroop effect interference is eliminated if only a single letter of the word is coloured (e.g. **R**ED).

Language interference is a well-reported bilingual phenomenon where the non-target language is activated unintentionally. Language Selective Access and Language Non-Selective Access are two theoretical explanations aimed to explain how languages can be activated and accessed (Dijksta, 2005). Language Selective Access theory assumes that a bilingual makes a choice between L1 and L2 when they see a word and activate lexical access accordingly. That is why bilinguals can be slower when targets are given in a mixed context (L1 and L2), rather than in a pure context (L1 or L2) (Moon and Jiang, 2012; Gerard and Scarborough, 1989). According to Language Non-Selective Access both languages are activated simultaneously (De Groot, 2011). De Groot and colleagues (2000) investigated how

Dutch (L1)-English (L2) bilinguals process words with the same written form but different meanings in L1 and L2 (interlexical homographs: e.g. 'glad' in English - 'slippery' in Dutch). Their study showed that stimuli (in target or non-target language) would give a raise to automatic phonological activation and that non-target language cannot be simply deactivated when target language is in use providing support for language non-selective access.

This brief discussion of psycholinguistic models along with introduction of early empirical investigations of bilingual language processing will be continued in Chapter 3 and Chapter 4. Further, the focus of attention will switched to factors that can influence the language processing of bilingual speaker, such as the features of different writing systems.

2.4 Factors affecting bilingual language processing

Some of the factors that have been reported to influence bilingual language processing will be briefly discussed in this section. A number of studies have shown that the greater exposure to L2 at the beginning of bilingual experience the more advanced is the L2 acquisition (e.g. Gathercole, 2007; Gathercole and Mon Thomas, 2009; Paradis, 2009; 2010). Paradis (2011) argues that input quality which refers to language variation that exists in bilingual's environment plays an important part in L2 acquisition. For example, the variation of dialects or different levels of language fluency can contribute to the learners' language processing. If there is a great variety of the L1 and L2 exposure this can potentially lead to "errorful" usage of some language structures.

One factor that has been reported since early investigations is the proficiency with which a bilingual can execute both L1 and L2 (see de Groot and Kroll, 2014 for a review). The role of proficiency and age of acquisition on L2 have been demonstrated to influence not only the behavioural aspects but also the way the bilingual brain becomes activated (Perani, Paulesu, Galles, Dupoux, Dehaene et al, 1998). In an fMRI study the authors employed two groups of participants to investigate the effect of early and late acquisition of L2 in highly proficient bilinguals: a) Italian-English bilinguals who acquired L2 after the age of 10 years (late L2) and b) Spanish-Catalan bilinguals who acquired L2 before the age of 4 years (early L2). Perani et al (1998) reported that ‘for pairs of L1 and L2 languages that are fairly close, attained proficiency is more important than age of acquisition as a determinant of the cortical representation of L2’. The behavioural implications of L2 proficiency on the current study will be further discussed in view of theoretical models in Chapters 3 and 4.

One other influential factor in bilingual language processing is the orthographic features of the two languages. Particularly the difference between L1 and L2 orthographies and to what extent these differences affect language processing is a subject of interest. Several lines of inquiry on L1 and L2 orthographic differences have yielded the following findings: For example, Wang, Koda and Perfetti (2003) demonstrated differences in English word recognition between native speakers of Korean (syllabic orthography) and Chinese (logographic writing system); robust cognate effects, that is, words similar in spelling and identical in meaning in both L1 and L2 are recognised faster and more accurately than noncognates, as in Dutch-English bilinguals (de Groot and Nas, 1991) and in Hebrew-English bilinguals (Gollan, Forster and Frost, 1997; for an overview see Dijkstra, Grainger and van Hueven, 1999).

One further variable closely related to L1 and L2 orthography is the role of orthographic neighbours (i.e., words that differ from the respective word in one letter only; Coltheart, Davelaar, Jonasson and Besner, 1977) may play between languages. In a major bilingual study by Lemhöfer, Dijkstra, Schriefers, Baayen, Grainger and Zwitserlood (2008) native French, German and Dutch speakers were presented with a word identification task for 1,025 monosylabic English (L2) words. The results of the study showed that word recognition task is more influenced by withi-language than between-language factors; none of the L1 neighbourhood measures was found to be a significant predictor of RTs in regression analyses. Lemhöfer et al concluded that 'there was no evidence of cross-language neighbors from the participants native language becoming active upon the presentation of the English target word.' Additional comparison bilingual data with monolingual results showed subtle difference in language processiong between monolingual and bilingual speakers.

The orthographic differences of English and Russian and particularly the influence of the features of writing systems on semantic priming will be discussed in detail in Chapter 6. To conclude, research on understanding mental processes involved in bilingualism is vast. The aim of this Chapter was to provide a summary of historical developments from methodological and theoretical perspectives as well as the classification of bilingualism. The relevance of the above theoretical and experimental frameworks used in bilingual research will be critically evaluated in Chapters 3 and 4, respectively.

3. Chapter 3: A review of theoretical frameworks in monolingual and bilingual lexical and semantic processing

Preface

The ability of the human cognitive system to store and organise language, and knowledge about words (phonological, semantic and orthographic representations) and to be able to retrieve those representations require multifaceted, interlinked and complex mental processes. In case of bilingualism, these processes are assumed to be even more complex as they are required to be executed for two languages. Despite this, as discussed in Chapter 1, majority of the human population is bilingual.

The aim of this Chapter is to provide a review of the theoretical frameworks that account for storing, organising and retrieval of lexical and semantic information from a psycholinguistic perspective. In addition, a brief review of the theoretical accounts of visual word recognition in the monolingual literature is essential in order to establish an understanding of how one recognises or reads printed words especially in accessing meaning. Put simply, semantic representations represent the meaning of the words; lexical representations (phonological and orthographic) refer to the forms of the words (e.g. Kroll and de Groot, 1997; Brysbaert et al, 2014). Below is an account of the role of long term memory in understanding bilingual psycholinguistic research because it provides a basis to understand one of the key issues explored in the current research programme, namely, how information is stored, organised and retrieved in the bilingual memory.

Models of Visual Word Recognition

The term orthography is taken to refer to a system of rules for transcribing or writing a spoken language, e.g. spelling, capitalization, punctuation and other (Henderson, 1982). Orthography defines a particular set of symbols and identifies the rules about how those symbols are used (Coulmas, 1996). The variation in writing systems, as will be discussed further in this part of the Chapter, can potentially influence the way different languages are processed.

The evolution of writing systems is believed to begin from concrete pictorial representations leading to the development of logographic orthographies, and finally to the more abstract letter representation seen in syllabic and alphabetic writing systems (Henderson, 1982; Skoyles, 1988). Classification of writing systems depends on their various properties one of which is orthographic transparency, i.e. how directly a writing system represents spoken language. Further in this Chapter issues related to orthographic transparency and studies that aimed to discover the role different orthographies play in lexico-semantic processing will be discussed.

The first and most primitive writing system can be considered to be pictography (Henderson, 1982). Pictography is an abstract representation of the idea without the mediation of spoken language. However pictographic representation of meanings faced some problems: pictographs require almost infinite number of linguistic representations and hence signs to remember. Also, for accurate representation of the idea's meaning requires a highly skilled mastery. Moreover the representation of abstract meanings in form of drawings or pictographs can be problematic, as they would be open for interpretation and misuse. The urge to eliminate issues related to pictographic representation led to development of logographic forms of representation.

Henderson (1982) explains the transition from pictographic to logographical writing system to be driven by the tendency of increasing stylisation and simplification to the *one sign = one word* principle. Logographic languages use the smallest meaningful units in the language, i.e. morphemes, to represent the spoken language. These units are usually monosyllabic and grammatically independent. Tense, plural and gender are represented by other special morphemic units, such as, in Chinese GO, WENT and GONE are represented by the same character and tense is indicated by separate morphemes (Hung and Tzeng, 1981).

However, logographic writing systems face similar problems to pictographic writing systems, that is, the representation of abstract concepts. Hence, Chinese eventually developed phonograms which are typically made of the following components: a significant component (meaning) accompanied by a phonetic marker. This method allowed to represent an infinite number of ideas and consequently led to simplification of their written representation. However, the problem for beginning readers of Chinese is to learn and distinguish between a huge number of logographic characters before the mastering the reading. In modern Chinese a number of phonological characters have been introduced to help with pronunciation using Pinyin. This influences the speed of language acquisition in logographic writing systems which are rather slow (see Hung and Tzeng, 1981 for a review). The logographic writing system can face a number of problems if the grammatical characteristics of the spoken language are more sophisticated. Thus when Japanese adopted Chinese logographic Kanji they had to additionally develop the Kana syllabary for adequate representation of the grammatical and phonological markers. Syllable-based symbols reflect phonological qualities without application of the meaning. Syllabaries are the next step towards the evolution of alphabetical writing systems.

Alphabetic writing systems based on principle that the written symbols (graphemes) represent the units/sounds of the spoken language: phonemes and syllables. However, the correspondence between written and spoken language is not exact. Orthographies of different languages also exhibit varying degrees of transparency, i.e. the directness with which one can generate phonology from print, which influences cognitive processing will be reviewed below in order to establish the role of orthography on lexical and semantic processing.

In summary, it can be assumed that three main types of writing systems exist: *logographic* (also known as idiographic writing system: each symbols represents a separate morpheme, e.g. Chinese language is the only one modern language that remains to be logographic); *syllabic* (each symbol representing syllables, e.g. Japanese and Korean languages); and *alphabetic* (a system of symbols made up of vowels and consonants which roughly represent spoken phonemes, e.g. English and Russian languages). From a psycholinguistic point of view alphabetical languages can be considered as the most economical for the cognitive system because once the relatively small number of rules of converting print to sound (and vice versa) are learnt then one can successfully navigate between the spoken language and the written form. Some writing systems can represent a combination of features of more than one of these types, for example consonantal alphabets of Hebrew and Arabic when only consonants are written down, but vowels are left out.

The impact of variation in orthographic transparency is an important factor that influences processes between different languages but also processes used within a given language. English orthography is well documented to have irregularities that require the reader to employ different procedures in order to successfully derive phonology from print (Venezky, 1970). For example, one would fail if they employed the same strategies in reading orthographically similar words GAVE, WAVE and HAVE. A seminal theoretical model in relation to converting orthography to phonology was proposed by Coltheart (1978), namely, the dual route model of oral reading (see Figure 1 for details) which considered the peculiarities of the English orthography by taking into account whether one could read English words accurately just by using Grapheme Phoneme Conversion rules (print to sound conversion rules or GPCs) or by using previously stored representations. Coltheart (1978) proposed i) a nonlexical route for when words can be successfully named using GPCs (i.e. assembled phonology via Route A) words such as GAVE, WAVE and SAVE and ii) a lexical route which is used to retrieve a previously stored phonological representation (i.e. addressed phonology via Route B) when GPCs would fail for words such as HAVE, YACHT and COLONEL from a mental dictionary or lexicon which is essentially a long term memory store for all the words a reader knows. When one considers the nature of the English orthography which represents both highly regular where one can successfully name the items based on GPCs as well as irregular words (such as HAVE, YACHT and COLONEL) for which GPCs would fail, one can fully appreciate the logic and the phenomenal success of the dual route model and it derivatives (see Coltheart et al., 1993; Coltheart and Rastle, 1994; Rastle and Coltheart, 1999 for the computational Dual-Route Cascaded (DRC) model).

In the early days of the model, Henderson (1984) claims that there was '*…an attempt to colonise the orthographies of the world with the dual-route model*' (p7), resulting in a strong claim which maintains that the route to be used is determined exclusively by orthographic transparency. According to this claim, opaque scripts, such as Hebrew, are named aloud via the lexical route, whilst transparent scripts such as Serbo-Croatian (Turvey, Feldman and Lukatela, 1984) '*constrains the reader to a phonologically analytic strategy*' (p81), i.e. the nonlexical route. This position is generally referred to as the orthographic depth hypothesis. A weaker version of the orthographic depth hypothesis, however, maintains that whilst both routes are available to readers of different writing systems, the degree of involvement of a particular route is nevertheless determined by orthographic transparency (Frost, Katz and Bentin, 1987).

In a highly influential paper, this position was challenged by Baluch and Besner (1991) in a study using Persian writing system which has both opaque and transparent words. Baluch and Besner (1991) proposed that lexical route is the universally preferred route for all orthographies irrespective of transparency. To confirm this suggestion two speed naming tasks were employed and showed that both semantic relatedness and word frequency effects performance of word naming if non-words are excluded. However, when non-words are part of the stimuli list, opaque but not transparent words will be affected. Transparent words yield frequency effect when non-words are excluded from the context. Hence it can be concluded that the results show evidence for lexical involvement in reading transparent words. This is contrary to the prediction of the orthographic depth hypothesis. Similarly, further research on extremely transparent Turkish orthography also showed involvement of the lexical route in naming (Raman, Baluch and Sneddon, 1996; Raman, Baluch and Besner, 2004). Raman et al (1996) study examine в single word naming in transparent Turkish orthography. Similar to Baluch and Besner (1991) study Turkish speaking readers relied on lexical information for naming when the set consists of word stimuli only. No frequency effect was found if an equal number of nonwords was implemented in the stimuli list along with real words. The results showed that readers relied on nonlexical route of naming. Hence this support the suggestion that the naming process is flexible and doesn't depend from the orthographic transparency.

Later the elimination of the word frequency effect in visual word recognition was investigated in a series of word naming tasks (Raman, Baluch and Besner, 2004). Native speakers of Turkish were presented with either a list of words or a mixed list of words and nonwords. Frequency effect was found in both sets of stimuli and rather influenced the setting of the time criterion: the magnitude of the frequency effect depends on the predictability of the next item in the naming block. Based on the results of this study the model was proposed in which both lexical and nonlexical routes are activated in parallel for Transparent Turkish orthography.

To summarise, orthographic transparency will be taken to refer to the directness from which one can derive phonology from orthography in alphabetic orthographies. Alphabets of the world vary greatly in orthographic transparency on several levels including but not limited to the relationship between letters and sounds and vice versa, and in syllabic complexity (Georgia, Niolaki and Masterson, 2012).

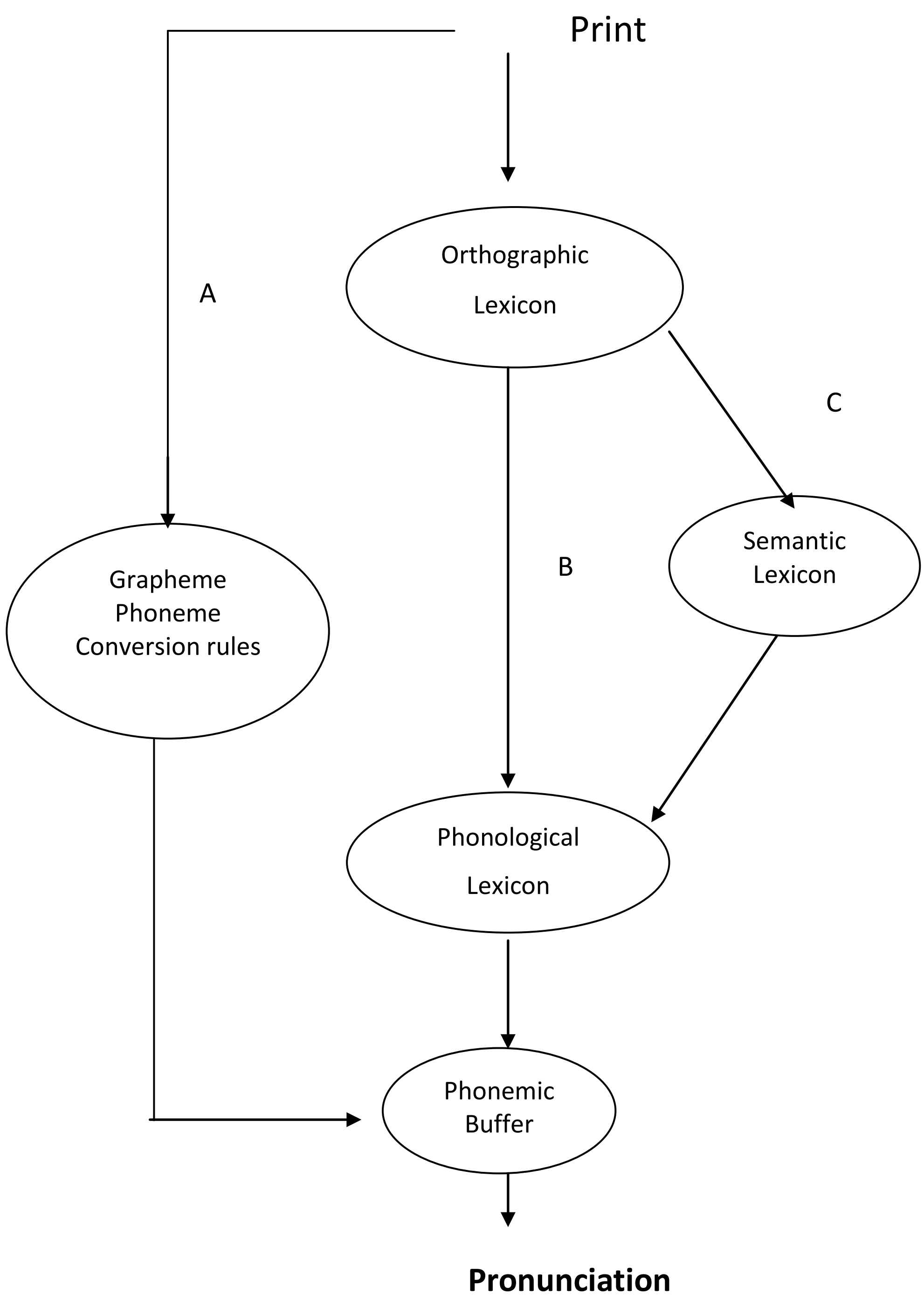

Figure 1: Dual-Route Model of Oral Naming (adapted from Besner, 1999)

Semantic networks

Theories of language processing assume three different types of representation in long term memory for each word: phonological (sound), orthographic (spelling) and semantic (meaning) (Coltheart, 1978; Rastle and Coltheart, 1999). In turn, each word is assumed to be associated with other conceptually related words creating semantic networks as shown in Figure 2 below (e.g., Collins and Quillian, 1969).

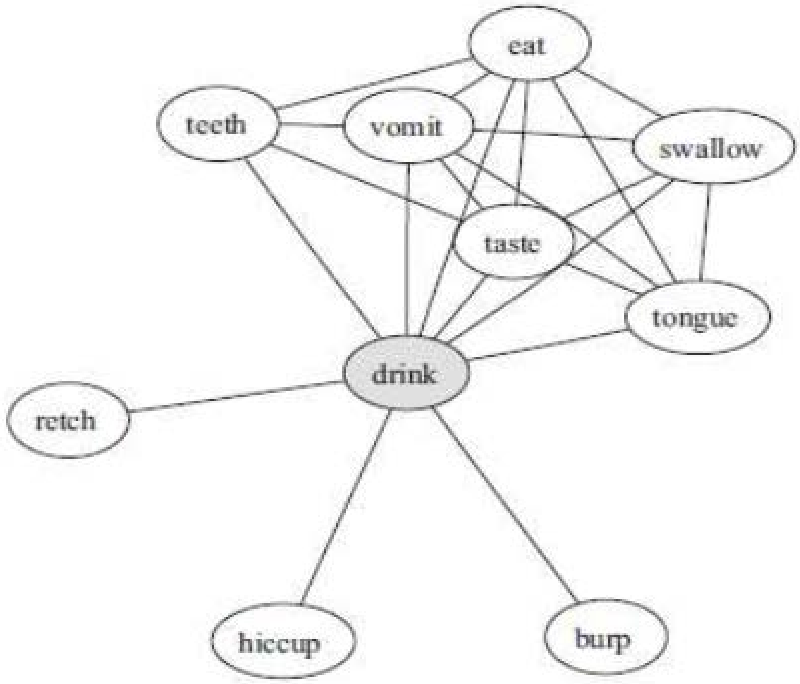

Figure 2: An example of a semantic network for 'DRINK' adapted from Andrews, Vigliocco, and Vinson (2009)

In a recent review, Brysbaert and colleagues (2014) argue that a distinction exists between two levels of word-related information, namely, a level of semantic representations and a level of lexical representations that involves the selection of the most highly activated representation or node within a network. (e. g., Kroll and de Groot, 1997; Malt, Sloman, Gennari, Shi and Wang, 1999). Word associations, therefore, can be translated into networks of nodes (memory) that are interlinked hierarchically to each other. A particularly interesting idea of networks for the organisation of a long term memory system, such as the lexicon, is that interconnected units of information, i.e. nodes/memories, are connected through the principle of spreading activation (Collins and Loftus, 1975). According to Neely and Kahan (2001) spreading activation principle assumes that words in a given network are activated automatically, that is, the process is fast, occurs without intention, is involuntary, and can occur without conscious awareness. The model is useful in explaining semantic priming, that is, the faster and more accurate retrieval of information, i.e. the target, from memory if related information, i.e. the prime, has been presented a short time before. This is because semantically related concepts are assumed to form stronger links or may be stored closer together than those concepts that are unrelated (Neely, 1991). When one node is activated, activation spreads along the network to other concept nodes that are located nearby. The semantic-priming effect is argued to arise because the activation of a semantically related prime word leads to shorter response times to the target word, since the distance between related a prime-target pair (e.g. drink-taste) is shorter than an unrelated prime-target pair (e.g. drink-swallow).

The appropriateness of the semantic priming paradigm as an experimental method in understanding semantic memory will be critically reviewed from a monolingual and a bilingual perspective in Chapter 4.

Common versus separate stores models

Bilingual mind is not a simple combination of two monolingual languages, but a unique system of communication that can use both languages or switch from one language to another depending on a subject and situation (Grosjean, 1997a). A critical question that was raised in this respect during the 80s was whether the two languages of a bilingual were stored in one or two memory stores. According to the separate store model (Potter et al, 1984), there are two separate lexicons for each language while according to the common store model (Paivio, Clark and Lambert, 1988) there is one memory store for both languages. In common-store models there is only one lexicon and only one semantic memory system, hence all the words from both languages are stored in the same memory store and connected directly together. Common-stored models supported by the evidence from bilingual studies that showed that semantic priming produces facilitation between-languages (e.g., Chen and Ng, 1989; Jin, 1990).

Word association versus concept mediation models

Potter et al's (1984) word association model is one of the earlier theoretical accounts for bilingual language storage primarily based on the principles of semantic networks and spreading activation in which L1 and L2 have separate representations for words, i.e. two stores, one for each language (see Figure 3).

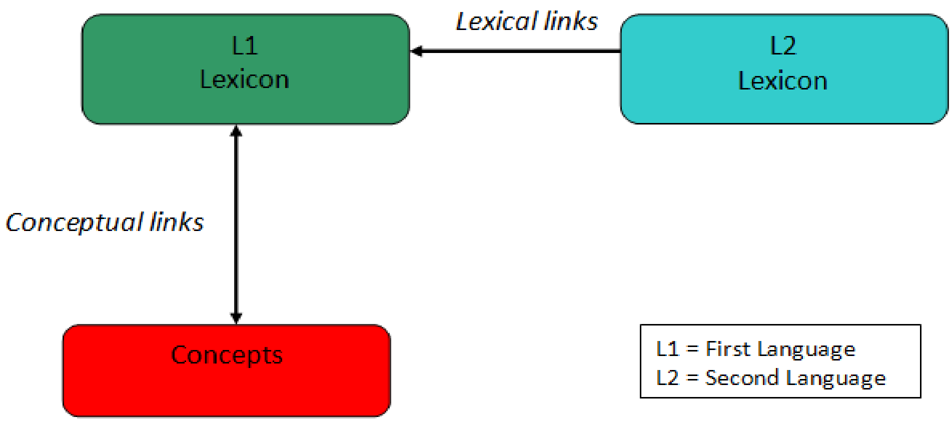

Figure 3: Word association model adapted from Potter et al. (1984)

The concept mediation model (Potter et al, 1984), as can be seen in Figure 3, proposes a separate, independent direct link between the conceptual representations for each language, one for L1 and another for L2.

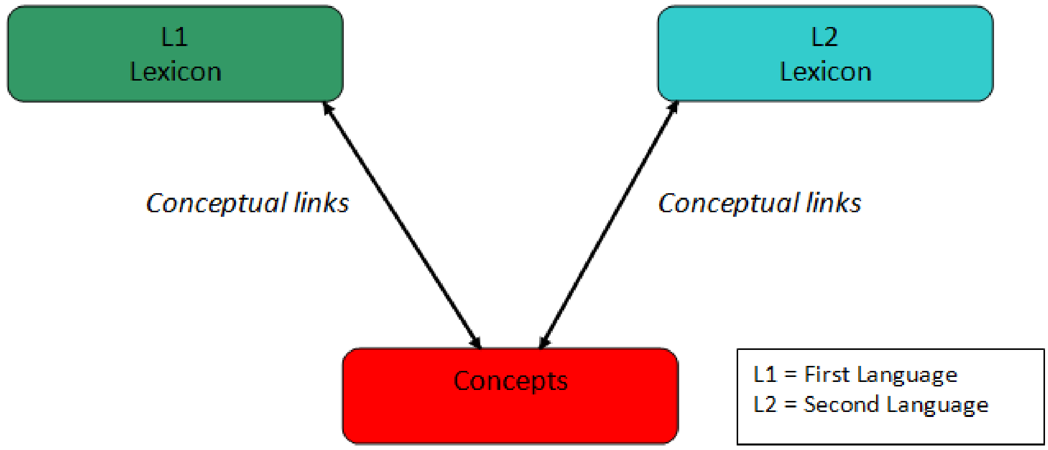

Figure 4: Concept mediation model adapted from Potter et al. (1984)

The Bilingual Interactive Activation (BIA) and BIA+ models

The BIA model proposed by Van Heuven, Dijkstra and Grainger (1998) was modelled on McClelland and Rumelhart's (1981) Interactive Activation model for English word recognition. McClelland and Rumelhart's (1981) model was primarily developed to explain the word superiority effect. That is, the faster recognition of individual letters when presented in words (e.g. the letter K in the word WORK) than when compared to in nonwords or other random letter strings (see Reicher, 1969 for a details). Based on word superiority effects it was concluded that perhaps in the process of visual word recognition, information from higher (word) level interacts in the recognition of information at a lower level (letter features, letters). This could thus suggest that representations in the lexicon are not word-specific, but that different units or nodes represent different visual information regarding words. This could be in the form of letter features, letters and whole words functioning in an interactive manner. These units are assumed to be organised in layers in a large network hierarchy that is fundamentally connectionist in structure. Three layers of units are proposed: Input (stimulus), hidden and output (response). Connections or pathways consist of adjustable weights that determine how much activation has passed. Units which share information are interconnected by excitatory pathways (e.g. A and AN) and those units that do not share information are interconnected by inhibitory pathways (e.g. A and THE). Recognition of a word is possible when a unit specific to the information (i.e. whole word, letters, letter features) exceeds its activation level and activation then spreads by means of excitatory-inhibitory connections through the network. McClelland and Rumelhart's (1981) model is considered as an example of a connectionist model whereby its representations are nevertheless still localist not distributed in nature (see Besner, 1999 for a review). According to the IA model the language processing is activated from the bottom up starting from letter features to letters and finally to the words (McCelland and Rumelhart, 1981). The development of this radical theoretical architecture regarding representations encouraged investigators to reconsider how readers may recognise print and led to the evolution of a new breed of models of visual word recognition in bilinguals, as introduced in this section.

The BIA model is a computational model which uses parameters of frequency to simulate the mechanism of language acquisition. According to the BIA model, lexical processing is universal across languages and that the lexical access is not a selective and parallel process for L1 and L2. However, bilingual language processing still requires to have a certain basis for which of the words can be selected. The main difference of BIA model from IA is the fact that two new levels have been added for L1 and L2: words (L1 and L2) and language (L1 and L2) (see Figure 5). Potentially the word frequency effect, list context effects, and neighbourhood effects can be taken into an account in simulation studies. The highly frequent words are usually recognised quicker than less frequent words. The frequency parameters were divided into seven increasing developmental stages. Van Heuven and colleagues (1998) conducted a series of lexical decision experiments aiming to investigate how visual word recognition in one language will be affected by presence of orthographic neighbors from Dutch (L1) or English (L2). Orthographic neighbours are words that share a substantial number of letters and have an input from greater number of letter units. This is why such words will inhibit their neighbours even if inhibited words are not highly frequent. Nevertheless, highly frequent words will be activated quicker than words with low frequency. Five simulation studies have been conducted and showed that L2 can have an effect on L1 processing. For instance, learning English as L2 negatively influenced Dutch (L1) processing, but if Dutch was learnt as L2 then its influence on English (L1) processing was positive. Also the results demonstrated that early L2 acquisition is more efficient than if L2 is learnt later. The orthographic neighbourhood effect is also influential in language processing (van Heuven et al, 1998). The study results showed that the increasing number of Dutch (L1) orthographic neighbors inhibits reaction time to English (L2) target words for Dutch-English bilinguals. However, the increased number of target language neighbors facilitates response time in lexical decision task. Taking into an account these results an assumption was made that words from L1 and L2 are activated in parallel in an integrated Dutch-English lexicon.

However, some words cannot be recognised by BIA which has such semantic characteristics as cognates (words that have similar spelling and pronunciation in L1 and in L2) or false friends (words that have the same spelling, but different meaning). Cognates and noncognates are represented morphologically differently in the BIA model. Cognates share words' root (e.g. "porta-puerta", the root "port" is shared), noncognates have different roots (e.g. "taula-messa"). At the initial stage of the bilingual language processing cognate prime will activate letter nodes which are shared in two languages, the remainng words will be inhibited. At the recognition stage the word node corresponded to the cognate prime will be activated at morphemic level. This morphemic unit will send activation to to the node for its translation that shares the same root between languages. The actiation will be sustained at the bottom-up activation from the word level and at the top-down activation at the semantic level. Inhibition from the language node can affect the activation on morphological level (Kroll and De Groot, 2009).

The BIA model has been criticised for not simulating language development (e.g., Jacquet and French, 2002). Hence, Grainger, Midgley, and Holcomb (2010) suggested combining the Revised Hierarchical Model (RHM) (see Chapter 3.7 for a discussion) and the BIA model to explain the process of language development. These considerations led to adding the semantic level to the language level: the semantic of L2 is learned via associated semantic of L1 words. The direct link between L2 and semantic level is assumed to be accessed after frequently being exposed to L2 words.

However the adding of the semantic level to the original BIA model was not enough to explain the mechanism of language development and the BIA model has been updated to the BIA+ model (Dijkstra and Van Heuven, 2002). The BIA+ model consists of two inter-correlating subsystems: the word identification subsystem and task/decision subsystem which include both phonological and semantic lexical representations. The word identification subsystem includes all three levels: orthographic, semantic and phonological identification of the words. The task/decision subsystem is an independent mechanism based on the output of the word identification process, i.e. what decision has to be made after the word is identified and the meaning is retrieved. Therefore, the BIA+ simulates not only orthographic representation, but takes into an account phonological and semantic representation. All three representations provide an output for the task/decision system via words identification. The organisation of the word identification goes from bottom to top without an influence of the task/decision subsystem (see Figure 6).

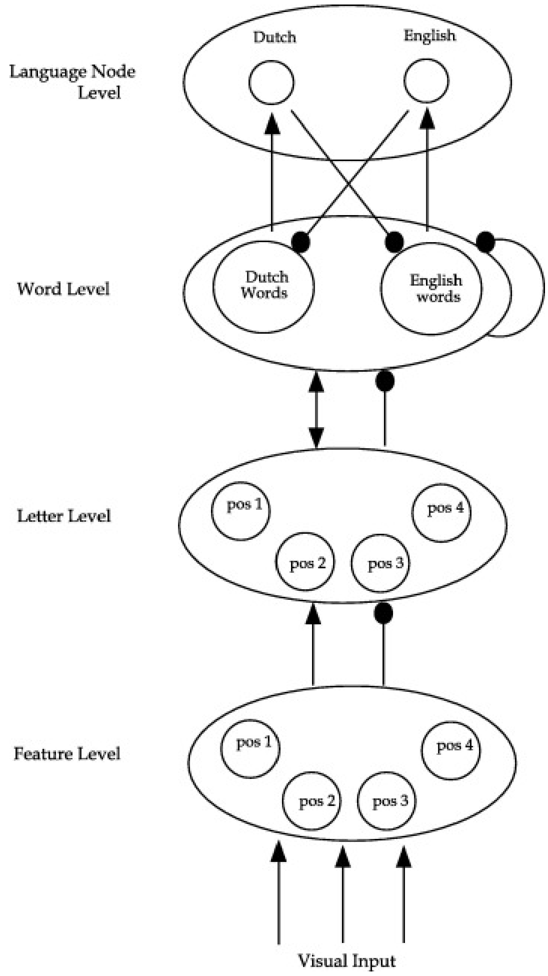

Figure 5: The Bilingual Interactive Activation model (van Heuven et al., 1998).

According to the BIA+ the word identification process goes through several consequent stages in the bilingual mind (Dijkstra and Van Heuven, 2002). For example, when bilingual Spanish-English speakers see the Spanish word *advertencia,* this has to be identified as a Spanish word and be differentiated from a similar English word such as *advertisement* which has a different meaning. At this stage at the semantic level the Spanish word *advertencia* has not only been translated to English as word *warning*, but also be distinguished from the orthographically similar English word *advertisement.* This information will be used by working memory in order to make a decision based on the information obtained from the word identification subsystem. After this, if the task was to translate from Spanish to English a decision will be made to use the translation for the Spanish word *advertencia* = *warning* and not to use the orthographically similar word in English, *advertisement*.

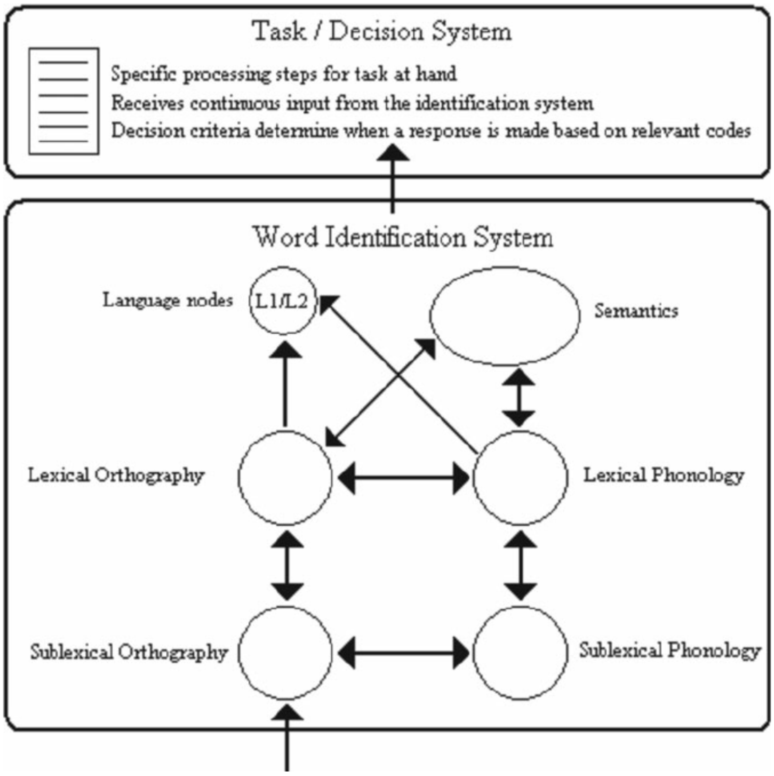

Figure 6: The Bilingual Interactive Activation Plus model (Dijkstra and Van Heuven, 2002)

Although it is not within the scope of the current research programme to employ the BIA+ model, this assumption makes it interesting to see if the process of word identification will be similar within orthographies which shares most of the letters with some unique letters, as in the case of Russian – English orthographies reported in Chapter 5.

Revised Hierarchical Model

Kroll and Stewart's (1994) Revised Hierarchical Model (RHM; Figure 7) integrated both accounts, that is, word association and concept mediation, and proposed that both L1 and L2 words share conceptual representations (one store) as opposed to the word association model by Potter et al (1984) who suggest that L1 and L2 have separate representations for words (two stores) one for each language.

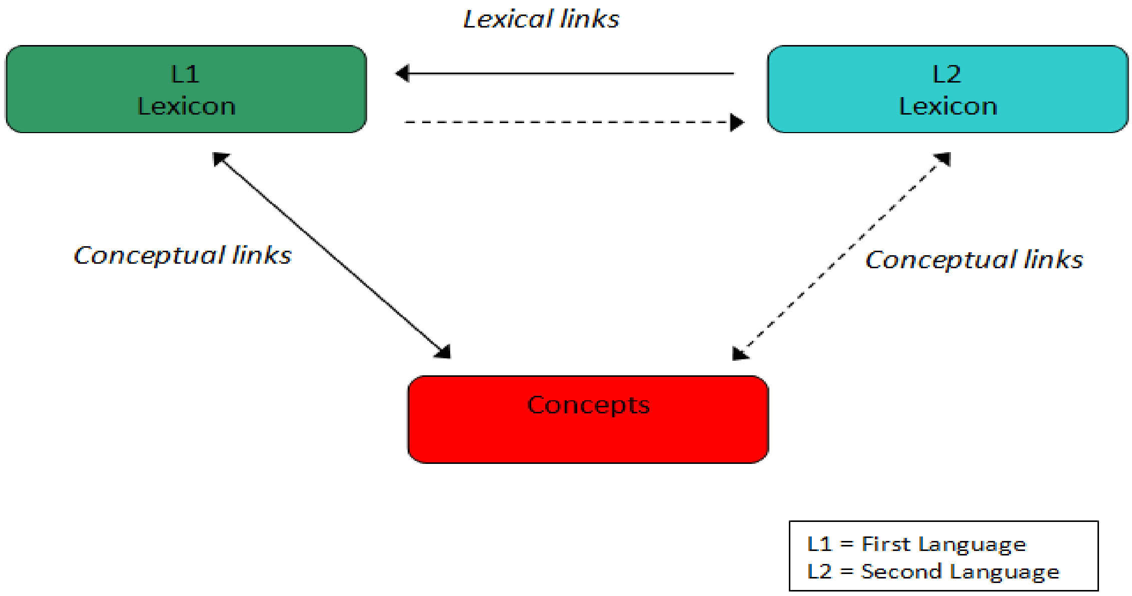

Figure 7: The RHM adapted from Kroll and Stewart (1994)

The RHM was primarily developed to explain the discrepancy in backward/forward translation findings in late bilinguals taking proficiency into account (Kroll and Stewart, 1994). When bilingual speakers translate words from L1 to L2 (forward translation) they are assumed to use conceptual mediation via direct access to the word meaning. While translating backward from L2 to L1, one has to have access to the word meaning via lexical representations, which is by word association. Backward translation is usually faster than forward translation (e.g., Kroll and Stewart, 1994; Sholl, Sankaranarayanan, and Kroll, 1995). A further assumption is that there is a large overlap in meaning between words in L1 and L2, especially in concrete words as they share more features compared to abstract words. Meanwhile, language-specific words and abstract words are not assumed to share representations in the bilingual mind. The more features in common L1 and L2 have, the easier the translation (Brysbaert et al, 2014). Schoonbaert, Duyck, Brysbaert and Hartsuiker (2009) assumed that semantic priming can be understood by observing the overlaps L1 and L2 have in forward and backward translation.

The RHM suggests that two levels of representation exist: the lexical or word level, and the conceptual or meaning level. At the lexical level, each language seems to be stored separately. Initially, words in L1 are assumed to gain direct access to meaning, whereas L2 words gain access to meaning via lexical links between L1 and L2 until proficiency in L2 is equivalent to L1. At this stage, a further assumption is that conceptual links are established between L2 and conceptual memory (see Figure 7).

In conclusion, the aim of the present research programme is to put the assumptions of the RHM in relation to lexical and conceptual links to the test and will be used in the explanation of findings from monolingual and Russian (L1) - English (L2) bilinguals.

4. Chapter 4: A review of experimental paradigms employed in bilingual research

'Every linguistic item has its 'place' in a system and its function, or value, derives from the relations, which it contracts with other units in the system' (Lyons, 1968, p443).

1.1 Preface

The aim of this Chapter is to provide a critical evaluation of the experimental paradigms employed to examine bilingual language processing in psycholinguistic studies from a historical perspective.

Stroop Task in Bilingual Research

Historically, the bilingual version of the Stroop task attracted attention from early researchers when the focus shifted from case studies to experimental paradigms, (e.g. Preston and Lambert, 1969). In the traditional Stroop task (1935, Experiment 1) participants were asked to read words in black versus incongruent colour, e.g. GREEN printed in red ink as GREEN, and the participant is required to ignore reading the word out as 'green' and name the colour of the ink as 'red'. The aim was to examine the interference of activation of nontarget information on the target and a highly significant interference from incongruent words in naming colours supported this. According to Posner and Snyder (1975) '… the usual Stroop effect arises because of response competition between vocal responses to the printed word and the ink color... Second, the direction of interference depends upon the time relations involved. Words are read faster than colors can be named, thus a color naming response receives stronger interference from the word than the reverse.. . . Third, words often facilitate the vocal output to colors with which they share a common name.. .

.These three results suggest that color naming and reading go on in parallel and without interference until close to the output, (p. 57)'

Stroop test has also been employed to explore whether one or two lexicons exist in the activation of L1 and L2 in bilinguals (Preston and Lambert, 1969). As previously was reported, monolingual Stroop task shows within-language interference when the ink of the word given and its colour are incongruent (for example BLUE). The question was raised if language interference will take place when the words are printed in one language, but word colour naming is in another.

Variations of the Stroop test became popular to investigate the semantic relationship between bilingual's first (L1) and second language (L2) (e.g. Bril and Green, 2013; Marian et al, 2013; Roelofs, 2009; Rosselli et al, 2002; Sumiya and Healy, 2004). For example, Roelofs (2009) studied Dutch (L1) - English (L2) bilinguals asking participants to name colours of the words given in Dutch and English. This research was replicated by Bril and Green (2013) with English (L1) - Russian (L2) speakers. Both studies showed the same level of interference in the first (L1) and second language (L2), which suggested that bilinguals access both languages simultaneously.

Therefore, according to the singular lexicon model, the bilingual Stroop task would show no interference because the colour naming in L1 and L2 would originate from the same lexicon and there would be no parallel language activation from L2. However, in a number of bilingual Stroop studies between-language interference took place when the colour naming performance and the colour of the word's ink were incongruent (Preston and Lambert, 1969; Chen and Ho, 1986; Tzelgov, Henik and Leiser, 1990 among others). These results were the same in language pairs of the same type of orthography (e.g. Perton and Lambert, 1969: French and English alphabetic systems), but even between-languages of different orthographic systems such as with Chinese (L1) – English (L2) bilinguals (e.g. Chen and Ho, 1986). Also, it is important to note that the level of language proficiency can significantly influence interference. For instance, with proficient bilinguals language interference was greater in within-language colour naming than in between-language (e.g., Chen and Ho, 1986; Preston and Lambert, 1969; Dyer, 1971; Tzelgov et al., 1990). Overall, between-language Stroop task has become a popular method to evaluate selective lexical processing when both L1 and L2 are activated simultaneously regardless language situation.

However, as discussed under Section 4.2, despite the contribution of Stroop test in between-language studies, one can argue that language interference measured by Stroop task alone is an artificial effect, when, under natural circumstances (reading) between-language interference may not happen (see MacLeod, 1991, for a review).

According to MacLeod (1991) 'Interference between the two languages of a bilingual, although not as great as that within either one of the languages, is very robust: Between-language interference typically is about 75% of within-language interference. Furthermore, a dominant language has more potential for interfering than does a nondominant one.' (p.187). Despite substantial evidence for between-language semantic contribution to Stroop interference, questions have been raised regarding the validity of the Stroop paradigm as a test of bilingual language processing and organisation (see MacLeod, 1991, for a review).

Lexical Decision versus Naming tasks

The following section will provide a review of lexical decision and naming tasks in view of the aims of this research programme. It is necessary to make a distinction between the demands made by lexical decision tasks and naming tasks on cognition. Lexical decision tasks came about as a result of the seminal work of Rubenstein, Lewis, and Rubenstein (1971) and are non-verbal in nature whereby the phonological/orthographic (or semantic) aspects of stimuli are manipulated and participants are required to carry out decisions that involve consulting the mental lexicon.

Lexical decision task is a widely used experimental technique in bilingual studies in which participants are presented with a string of letters (words or nonwords) displayed on the computer screen and they have to decide whether the letter string is a word or nonword by pressing a key. Reaction time and the number of errors are measured. For example, in a bilingual study conducted by Gerard and Scarborough (1989) English (L1) – Spanish (L2) bilinguals were tested in a two-part lexical-decision task, employing the following stimuli: a) noncognates (spelling indifferent for L1 and L2, e.g. “dog“ and “perro“), b) cognates (the meaning and spelling is identical for L1 and L2, e.g. “actual“), c) homographic noncognates (the meaning is different, but the spelling is similar for L1 and L2, e.g. “red“), d) nonwords. The noncognates and cognates had similar frequency in both languages. In Gerard and Scarborough (1989) experiment bilinguals reject noncognates in L2 as fast as nonwords. The conclusion has been made that bilinguals can selectively process stimuli employing their knowledge of L1 and L2. It was shown that languages are in language-specific lexicons and word recognition requires separate access to the appropriate lexicon (Gerard and Scarborough, 1989).

However, further experiments showed that lexical decision task can be influenced by word frequency, that is, how common a given word is (Schreuder and Baayen, 1997; Keuleers, Diependaele and Brysbaert, 2010). Words that are more frequent are recognized faster and more efficient than less frequent words.

The primary concern is thus to investigate the nature of the representation used for accessing the mental lexicon. Naming tasks, however, attempt to identify processes used in generating sound (phonology) from print (orthography), therefore directly activating orthographic (spelling), phonological (sound) and semantic (meaning) representations in the lexicon (Coltheart, 1978; Morton, 1969). The following section provides a brief summary of several experiments in bilingual research employing lexical decision and naming tasks together with their findings.

In a lexical decision task with Spanish-English bilinguals Schwanenflugel and Rey (1986) found between-language semantic priming effects. Recognition of target words in one language following the primes of the other language was as fast as the target words following same language primes. Evidence from picture naming and translation tasks (Potter et al, 1984), and word association and lexical decision tasks (Van Hell and Dijkstra, 2002), support the notion that the two lexicons of proficient bilinguals are interconnected (see also Francis, 1999; Kroll and Sholl, 1992).

Evidence from lexical decision tasks with bilinguals also suggest that bilinguals activate words from both of their languages when making lexical decisions (DeGroot, Delmaar, and Lupker, 2000; Dijkstra, Van Jaarsveld, and Ten Brinke, 1998). However, in another study with English-Spanish bilinguals, Scarborough, Gerard and Cortese (1984) reported that the participants rejected English words as quickly as nonwords derived from English words (e.g. edan) and both were rejected more quickly than nonwords derived from Spanish. It was concluded that the participants only activated the target language. One criticism of the findings was the suggestion that the fast rejection of words in the nontarget language (English) was because of the unique orthographic patterns for Spanish and English words (Grainger, 1993).

The above issue regarding the implications of the uniqueness of orthographic patterns in bilingual language processing will be discussed in detail in Chapter 6 as the manipulation of the Russian Cyrillic and English Roman orthographies is a fundamental aspect of the current research programme.

One interesting research question in naming tasks is whether bilinguals activate phonological representations in the nontarget language during word naming. In order to address this question, Jared and Kroll (2001) tested English (L1) – French (L2) and French (L1) – English (L2) bilinguals. In a series of four experiments, participants named a block of English experimental (target) words, a block of French distracter words, and then a second block of English experimental (target) words. The main aim to include a block of French words was to see whether bilinguals would be more likely to activate bilingual spelling–sound language processing from L1 and L2 when named English words if they had recently used their French spelling–sound correspondences. Findings showed that phonological representations were simultaneously activated in both languages. However, this was dependent on several factors as follows: a) whether bilinguals were naming words in their dominant or less dominant language b) participants' fluency and c) experience with French d) whether English target words were named before or after the French distracters words (Jared and Kroll, 2001).

Based on the review above and for the purpose of this research programme, naming tasks will be employed as the preferred mode of experimentation because according to Seidenberg and McClelland (1989) the process of reading cannot be simplified by the choice between words and nonwords as in a lexical decision task. The focus will now shift to examining the semantic priming paradigm as an experimental method to examine semantic processing and how the two languages of a bilingual are organised; namely, whether they are stored in a single or two separate lexicons (see Kroll, van Hell, Tokowicz and Green, 2010 for a review).

Semantic Priming Paradigm

During the 70's and 80's, there was a surge of research that aimed to identify cognitive processes involved in semantic priming in order to establish a theoretical understanding of this robust phenomenon using different experimental paradigms such as lexical decision and naming tasks.

In the classic semantic priming task, participants are presented with either semantically related word pairs, e.g. DOCTOR-NURSE or unrelated pairs, e.g. DOCTOR–BUTTER, typically comprised of a prime-target and asked to name or make a word/non-word judgement of the second word (target) as quickly as possible. A reliable finding is that naming or making judgments on the target word is faster and more accurate when the prime is related (DOCTOR-NURSE) than unrelated (DOCTOR–BUTTER). This phenomenon is called semantic priming (Meyer and Schvaneveldt, 1971) whereby the main assumption is that priming is indicative of semantic and lexical organization (Kirsner et al., 1980). Although Meyer and Schvaneveldt (1971) study employed a lexical decision task, a similar effect was also found across different tasks, such as naming. However, this assumption was challenged by long-term priming effect and it has been argued that the priming paradigm can be a reflection of lexical as well as nonlexical sources (Forster and Davis, 1984). To overcome this effect the masking priming was introduced (de Groot and Nas, 1991) in which the prime is visually masked by hash marks and presented for a very short time prior to the target in order to minimise the risk of priming. Masked priming is widely used paradigm which refers to the fact that the prime word is masked by symbols such as ######. Mask can be used in forward (before the prime) or backward manner (after the prime word). The masks are presented for less than 80 ms, hence it cannot be perceived on the consiouse level and used to diminish the visibility of the prime. The aim of the masked priming is to investiagete automatic process of the visual word recognition. An interesting recent suggestion in this respect from imaging studies is that semantically related words are located in the same part of the brain (Pulvermüller, 2013).

Semantic processing requires complex cognitive mechanism and compromise different semantic features (e.g. sensory and functional) which main function is to define the meaning of the word. As was described in Chapter 3 semantic priming can be explained by spreading activation of processing unites (nodes) and their interconnections. The speed of spreading activation is determined by strength of connections between particular lexical items (primes and targets). Therefore, those words within one semantic network would be activated quicker and more accurate than words that do not have semantic relationships. The reaction to the target is quicker because in semantic network the distance between related words is shorter than between those words that do not share the same semantic network. Monolingual studies under different semantic priming manipulations have shown a robust effect (for reviews, see McNamara and Holbrook, 2003; Neely, 1991), yet between-language semantic experiments show ambivalent results and these will be discussed further. However, before the further discussion of the between-language experiments which employed semantic priming it would logical to discuss types of priming paradigm and how semantic priming differ from other types.

Types of Priming

Priming is an effect which occurs in long-term (or also known as implicit memory) when the presented stimuli (prime) influence the response of the stimuli presented afterwards (target). The experiments conducted by Meyer and Schvaneveldt in the early 1970s were first to bring light to priming paradigm and eventually led to the development of further priming experiments of different types. Over the years the usage of semantic priming as a tool for psycholinguistic studies has led to its division on different types (see Neely, 1991). The most common types of priming will be discussed below.

First of all, priming can be divided by the types of the stimuli repeatedly presented, e.g. perceptual, semantic, or conceptual stimulus repetition. Perceptual priming is based on the form of prime and different modalities can be involved in this process. However, priming effect works best when the stimuli are in the same modality, such as visual priming will be give the most significant effect when both prime and target are visual stimuli, but verbal priming will be the most influential with verbal cues. The example of perceptual priming is a task when participants are asked to complete the part of the picture which they have seen earlier. In the experiments with conceptual priming, a prime and a target are related by the idea (concept), e.g. as word “hat” is related to “head”. For the purpose of this report the further discussion will be mainly focused on semantic priming. Semantic and conceptual priming are quite similar and in literature these terms can be used interchangeably (Kolb and Whishaw, 2003).

Classification of priming types can be consider to reflect the types of priming effect which depends on the speed of processing (Reisberg, 2007). One example of this division is negative and positive priming. Positive primes speed up the processing; while negative primes slow the processing down. Negative prime is more complicated because the positive prime only requires simple registration of the stimuli whereas the negative priming also requires its inhibition. Positive priming is an unconscious process and involves the mechanism of spreading activation. In this respect, spreading activation can be considered as the quality of memory when the prime activates the association network (see Section 3.2 for a review of semantic networks) and the representation is partially activated when the target is encountered, hence less additional activation is required for the participant to consciously recognise the stimuli (Reisberg, 2007).

One of the forms of the positive priming is called repetition priming or also known as direct priming. Repetition priming can often be found in word lexical decision tasks. When the prime is presented to the participant a few times than further presentation of the stimulus is expected and will be primed. It means that repeated primes will be recognised faster and more efficient by the brain (Forster and Davies, 1984). Negative priming causes a conflict in perception of the stimuli by ignoring it and therefore hinders processing time Mayr and Axel, 2007). Also priming can be divided as perceptual and conceptual types. The difference lies in whether the focus research is in the perception of the form or of the meaning respectively. Perceptual priming is based on the form of the stimuli and depends on the extent to which the prime and the target match. The strength of perceptual priming depends on the modality in which both stimuli are presented. The perceptual priming is stronger if both prime and target are presented in the same modality (for example either both stimuli are verbal or visual). It has also been demonstrated that the exact format of the stimuli also influences the priming. For example, some studies showed that the presentation of visual prime does not have to be a perfect match for the visual target stimuli for the priming effect to emerge (Biederman and Cooper, 1992). Similarly, in the Word-Stem Completion (WSC) task, participants are presented with a few first letters of the word and asked to complete the stimuli with the first word which comes to their mind (Graf, Mandler and Haden, 1982). Despite the fact that the size of the visual prime differs from the target, stimuli still provides significant evidence for perceptual priming effect. On the other hand, conceptual priming is rather focused on the meaning of the word rather than its perceptual format. So that a word “table” will show a priming effect when paired with word “chair” because both words belong to the same category (“furniture”) and both stimuli are enhanced by semantic task (Vaidya, Monti, Gabrieli, Tinklenburg and Yesevage, 1999).

As discussed earlier, semantic priming is theorised to function because of the effect of spreading activation. In semantic priming tasks both the prime and the target share the same semantic features (Ferrand and New, 2003). Such as the word “doctor” will be primed by the word “nurse” because both of them are belongs to the category “hospital”. When a person is presented with one of the items from a category, similar items are stimulated by the brain. Sometimes it is challenging to distinguish between semantic and associative priming. In associative priming, words are highly related and prime can be closely associated with target, but not to be semantically related (e.g. “cat” and “dog”). In associative priming, words traditionally quite often are used together; for example in phrases like ‘raining cats and dogs’ (Matsukawa, Snodgrass and Doniger, 2005). Similar effects can be found in context priming when the context is used to speed up the activation. In context priming the gramma and structure of the word primes the word which appears in the sentence later. Hence, words in the situation of context priming will be processed quicker than if they read alone (Stanovich and West, 1983; Matsukawa, Snodgrass and Doniger, 2005).

Mechanisms Involved in Priming: Automatic versus Attentional processes

According to Neely (1977) priming involves at least two different priming types based on the processing mechanisms: automatic and attentional processing. Automatic processing is fast, often unconscious and does not require involvement of working memory, not interfering by competing tasks. Attentional processing, on the other hand, is often consciously controlled, sensitive to interference and uses the space of working memory.

Neely (1977) argues that semantic priming can be categorised as a) associative and b) non-associative semantic priming. In associative semantic priming, participants produce the target word in response to the prime which is related in meaning. In word association tasks, relationship between words can be measured by association norms (Postman and Keppel, 2014). Words are not always associated in both directions, e.g. if one is asked to say the first word that comes to mind when they hear ‘SOAP’ they would probably produce the word ‘BATH’. However, the word ‘BATH’ itself would not necessary facilitate the word ‘SOAP’. Also, in associative priming two words can be, e.g. DOG-CAT or cannot be semantically related in meaning, e.g. WAITING-HOSPITAL. Non-associative words related semantically do not have associative connections, for example ‘BREAD’ is not associated with the word ‘CAKE’, but related in meaning. The same is also true for words of the superordinate category would not necessary related with category instances, e.g. ANIMAL-FOX.

For example, in a Russian (L1) - English (L2) experiment the same facilitation effect between prime ‘donkey’ (L2) and target ‘лошадь’ (horse) (L1) is the same as between semantically related L1 words [‘осел’ (donkey) and ‘лошадь’ (horse)] indicating shared semantic representation between L1 and L2 and direct access to the words’ meaning from both target and not-target languages. This effect was first discovered and examined in the 1980s and the 1990s (e.g. Chen and Ng, 1989; de Groot and Nas, 1991; Frenck and Pynte, 1987; Jin, 1990; Keatley, Spinks, and de Gelder, 1994; Kirsner, Smith, Lockhart, King, and Jain, 1984; Schwanenflugel and Rey, 1986a, 1986b; Tzelgov and Eben-Ezra, 1992). In the experiments mentioned above various approaches were used, such as, different types of semantic relationships when the bilinguals level of L2 acquisition or age were not controlled; in these studies different time and styles of presentation prime and target were used (Altarriba and Basnight-Brown, 2007). More recent studies controlled factors in the semantic priming paradigm (e.g., Duyck, 2005; Perea, Dunabeitia and Carreiras, 2008; Schoonbaert, Duyck, Brysbaert and Hartsuiker, 2009). Semantic priming effect was found in the studies when prime presented in L1 (e.g., Altarriba and Basnight- Brown, 2007; Perea et al., 2008), but some studies did not showed a significant difference in prime effect in L1 and L2 if prime was presented in L2 (Altarriba and Basnight-Brown, 2007; Duyck, 2005). Guasch et al (2011) assume that this fact can be explained by the bilingual’s level of fluency in L2. Only when bilinguals were balanced in L1 and L2 the results of experiment showed prime effect in both languages (Perea et al., 2008).

For the purpose of this report, the choice was made to employ semantic priming in the series of monolingual Russian and bilingual Russian (L1) – English (L2) experiments. The semantic in semantic priming means that priming is caused by true relations of the meaning. Hence, the particular interest induces the exploration of semantic effects in a bilingual context. Semantic priming is traditionally the most common type of priming in psycholinguistic experiments, particularly in word naming and word recognition tasks (Harley, 2013).

Within versus Between-language Semantic Priming

Bilingual semantic priming tasks tend to use either within or between-language manipulations in order to address key questions raised above. The aim of this section is to provide a theoretical review for the phenomenon of within (L1-L1 and L2-L2) and between (L1-L2 and L2-L1) language semantic priming. Establishing within-language semantic priming is seen a prerequisite prior to conducting between-language experiments. This is because in order to be able to understand how L1-L2 and L2-L1 memory is linked, one must firstly establish a baseline measure of L1-L1 and L2-L2 effect in priming (Altarriba and Basnight-Brown, 2007). As has been discussed above, semantic priming is a universal tool to examine whether both languages of bilingual speaker are stored in one or two separate lexicons (e.g., Kroll, van Hell, Tokowicz and Green, 2010). In bilingual studies, semantic priming is a subject of particular interest because between-language priming can explain how and the extent to which two languages are interlinked (Kroll and De Groot, 1997; Kroll and Tokowicz, 2001). The next step in this report will focus on between-language semantic priming experiments to provide a comprehensive account from a theoretical perspective.

Semantic priming is a complex phenomenon, especially in between-language environments when the features of L1 and L2 orthographies significantly differ. Therefore, the aim of this section is to evaluate the current literature on between-language semantic priming paradigm and will be divided in two parts: first part will be focused on the literature review of between-language semantic priming phenomenon and further, in the second part, the focus will be shifted to the discussion of different writing systems and to what extent the orthographical differences can influence semantic priming effect.

In the last 40 years, a number of studies have been conducted to address the questions i) how two or more languages are stored and ii) organised in bilingual memory. The structure of lexical memory continues to be a subject of intensive investigation in the area of cognitive psychology. The semantic priming paradigm has been employed as a popular method to explore lexical and semantic organisation in monolingual and bilingual minds and is based on the concept that the meaning of the word is activated automatically when the word is presented, but also other semantically related words will be activated as well due to spreading activation of semantic network (Collins and Loftus, 1975; Collins and Quillian, 1969). The semantic priming paradigm is one of the most commonly used experimental techniques utilised to explain how bilingual individuals represent their languages in a memory. A number of between-language studies have employed semantic priming (e.g. Chen and Ng, 1989; Frenck and Pynte, 1987). As reported in Chapter 3, initial studies on lexical representation explained bilingual's language memory as either one or two separate memory structures (Scarborogh, Gerard and Cortese, 1984; de Groot and Nas, 1991). The starting point for a number of between-language studies was to explore whether or not bilinguals have common conceptual store for both L1 and L2, and separated lexical memory for each of their languages (Kroll and Stewart, 1994; Potter, So, Von Eckardt and Feldman, 1984).

However, experiments conducted in a two-way directions have shown a wide range of results; some of them show a robust semantic priming effect, when other experiments do not find significant results (for a review, Basnight-Brown and Altarriba, 2007). In some studies semantic priming effect was examined only in one direction either from L1 to L2 or from L2 to L1 (e.g. Larsen, Fritsch and Grava, 1994; Williams, 1994). Larsen and colleagues (1994) examined Latvian (L1) – English (L2) bilinguals and results of their one-way study showed evidence in support of separate storage model: when participants saw a word in one language (L1) it prepared them to pronounce a word in the same language (L1), rather than to switch to L2. However, in the studies mentioned above, semantic priming was not conducted from L2 to L1 which makes the results highly questionable. Later studies took into an account the fact of priming asymmetry as commonly reported phenomena and focused primarily on examining the L2-L1 language direction, such as in Japanese (L1) – English (L2) speakers (Finkbeiner, Forster, Nicol and Nakamura, 2004); Chinese (L1) – English (L2) speakers (Jiang and Forster, 2001).

One of the early studies reported by Stewart and Kroll (1990) aimed to explain why backward translation (from L2 to L1) is faster than forward translation (from L1 to L2) using the semantic priming paradigm. This phenomenon was explained by the assumption that conceptual links between words in L1 and L2 can be asymmetrical and that the level of language proficiency in less dominant language cause this translation differences. These ideas were summed up in the Revised Hierarchical Model (RHM) of Bilingual Memory Representation (Kroll and Stewart, 1994; see Chapter 3 for a review of RHM). It was assumed that vocabulary in L1 is larger than in L2 and the links between native language and concepts are stronger than with L2 and bidirectional. In the process of L2 acquisition, words from non-native language are assumed to be integrated in memory via lexical links with L1. When a person is not proficient enough in their L2, they have to rely on translations from L1 to L2 and the links of non-native language with conceptual store is considered to be weak. As L2 proficiency increases this link with concepts increases in strength. The RHM model attempts to explain how L2 proficiency influences the way information can be accessed at the conceptual and lexical levels. However, the fact that new words of L2 are stored in L2 lexicon only has been argued and it was suggested that new words are represented in both forms of entry: lexical and conceptual. Moreover, there is an assumption that not all the words can be represented in the common conceptual store just because some of the words are language specific and have no direct translation into the other language (Altarriba, 2000). Between-language semantic priming studies that employed word naming task in bilingual context will be discussed further in this Chapter.

As has been discussed in this Chapter, evidence from a number of bilingual studies including application of lexical decision, word naming or word-fragment completion tasks showed that activation of words from L2, under conditions that does not require it, seems to be inefficient. Thus, a number of studies provide evidence to support the statement that bilingual speakers can access each of their language independently avoiding cross language interference. That means that bilinguals can use only one lexicon in a particular period of time, switching from L1 mode to L2 mode and vice versa. However, more recent studies challenged the theory according to which bilinguals' two (L1 and L2) lexicons are separate and independent. The opposing theory suggests (Potter et al, 1984) that L1 and L2 are activated simultaneously even if conditions are appropriate for one language activation only.

In summary, the semantic priming paradigm became central to help to find answers to this question. In studies that employ semantic priming between languages, prime can be presented in L1 followed by target in L2 and/or in reverse order and is often referred to as language direction. For example, in an English-Spanish experiment prime can be given in one language (e.g. "cat") followed by the target in Spanish (e.g. "perro" or "dog"). Moreover, prime and target can be presented in opposite direction, e.g. “gato-dog”, when “gato” is Spanish translation for English prime “cat”. Insofar as the order of prime and target presentation is concerned, for the purpose of simplicity and consistency in this thesis the term one-way will be used to indicate if experimental conditions are from either L1 to L2 or L2 to L1; similarly, the term two-way will be used to indicate if primes and targets are presented both L1 and L2. Such manipulation with languages of primes and targets allows researcher to compare results of the semantic priming of each language direction. This concept has been employed in a more than a dozen between-language studies during the past three decades (Chen and Ng, 1989; Frenck and Pynte, 1987 and others).

Two major experimental tasks are traditionally in use within semantic priming studies, namely, lexical decision and word naming tasks. The following section examines studies employing different types of reading experiments aimed to investigate bilingual language processing. Beauvillain and Grainger (1987) researched bilingual French (L1) – English (L2) speakers where the participants were presented with a list of words for lexical decision in one language following by a list of words in another language. The question was would French word COIN prime lexical decision for the following English word MONEY. The results of the study showed that between-language facilitation effect take place in the very early stage of language processing (150ms SOA, Stimulus Onset Asynchrony), but simultaneous activation of both languages disappears later and at 750ms SOA is not found. In the following experiment Beauvillain and Grainger (1987) discovered that word frequency influences the magnitude of priming. The facilitation effect from French (L1) to English (L2) was greater than backward facilitation effect from L2 to L1. These findings led authors to conclusion that word frequency determines lexical access supporting the theory that bilingual visual word recognition in early stage of processing is language independent. Beauvillian (1992) argued that bilingual lexical word processing in tasks focused on visual word recognition is driven by orthography, but not language, and that before the lexical representation of the stimulus its orthographic properties will be composed. Grainger and Dijkstra (1992) suggested that both lexical and orthographic representations of the words are activated simultaneously and are not language specific. They proposed that words from both languages that have shared letters are activated automatically at the early stage of visual word recognition and this effect can be found within and between languages. According to Grainger (1993) language information, particularly the identification of which language a word belongs, facilitates bilingual visual word recognition. However, it suggested that non-target language is always operational and hence smooth the progress of between-language interference. Subsequently, it was put forward that selective language activation is less possible than simultaneous activation of L1 and L2, though at different levels or degrees of activation (Li, 1996; Grosjean, 1997). Although, Li and Grosjean in their studies didn't find evidence that both languages can be activated in the same time even when there is no external presence of the second lexicon. Later Grosjean (1997, 1998) argued that the nature of the experiment when prime is given in L1 and target in L2 did not allow to avoid lexical input from both languages and questioned what would happen if no input from the other lexicon is presented at all.

Masked versus Visible Semantic Priming

Automatic and attentional mechanisms involved in semantic priming experiments are discussed in detail under Section 4.4.2 of this Chapter and have been closely related to the processes involved in masked and visible semantic priming tasks respectively. While masked priming has been reported to be an effective technique for examination of automatic processing involved in visual word recognition (Forster, 1998; Forster and Davis, 1984; Forster, Mohan, and Hector, 2003; see also Dehaene et al., 1998; Grainger, 2008), visible priming is a method used to examine attentional processes. Masking refers to the technique when the prime is hidden behind symbols such as ######. The prime can be masked in a forward manner (###### symbol is presented before the prime) or backward manner (after the prime ######) and presented for a very short period of time (SOA less than 80ms). It is assumed that these manipulations lead to the activation of an automatic, but not an attentional mechanism for semantic priming, hence the participants' ability to make attentional decision is eliminated. Evidence showed that even when the participants are unaware of the presence of the masked prime, they can still produce activation via the word identification system, i.e. semantic information can be accessed without full conscious awareness of the items' existence (Allport, 1977; Marcel, 1983). However, masked priming experiments have been criticised by a number of researchers (Ellis and Marshall, 1978; Williams and Parkin, 1980; Holender, 1986) as one cannot rule out that the primes presented under masked conditions have not reached conscious level of processing. Also, it is unclear if the meaning-related information received without conscious analysis can be identified appropriately to the extent when semantic processing is fully activated (Holender, 1986). Neuroimaging and behavioural studies showed that masked priming and visible semantic priming involve quite different processes in the brain. fMRI studies showed that visible priming involves global conscious access, while in masked priming processing is narrowed to unconscious processes (Kouider, Dehaene, Jobert and Le Bihan, 2007). Hence, it can be assumed that visible semantic priming reflects that processes involved in normal reading better than masked priming can.

Masked priming experiment is also a popular method in investigation of bilingual language processing. Bijeljac-Babic, Biardeau and Grainger (1997) studied parallel activation in bilingual visual recognition by providing participants with a masked prime (57ms) which was not long enough for participants' perception to report. They found that if both languages share the same alphabet (for example Roman alphabet is shared by German and English languages) than simultaneous activation of both lexical systems will take place even if the experimental condition seems to be monolingual. Hence, a 57ms long masked prime in one language when the target is always in another language can be enough to activate the second lexicon.

Van Heuven and colleagues (1998) tested parallel lexical activation using the orthographic neighbour paradigm. As has been discussed earlier in this chapter, the main aim of Van Heuven et al (1998) was to investigate how the bilingual word recognition in one language can be affected by the existence of orthographic neighbors from the same or another language. An orthographic neighbors is a word of the same length as a target language but which differs by one letter only. For the purpose of the study Dutch (L1) – English (L2) participants took part in a series of lexical decision task. Participants were presented with two blocks of items, 4 letters long words, one for each language. Each block consisted of 80 items, 20 for each of the 4 conditions. Conditions differed by the combination of orthographic neighbors in Dutch and English. One group of participants was presented with a block of Dutch words followed by the English block, the other group was firstly presented with the English block followed by the Dutch block. Participants were asked to identify and enter the target word. The number of orthographic neighbors varied for each block. The results of Van Heuven et al study showed that inhibitory effects have taken place when there is an increase in orthographic neighbours within one language inhibiting the other language, but facilitating the target language. These results support the theory of parallel language activation.

Altarriba and Basnight-Brown (2007) noted that it is beneficial to take into account the level of proficiency of bilinguals' two languages and also different ages of acquisition because both these factors may influence the magnitude of semantic priming. The aim of their study was to understand how for bilingual Spanish (L1) – English (L2) speakers, both languages are represented in memory. For this experiment, a priming paradigm was used under masked and unmasked conditions. In Experiment 1 participants were presented with semantically related words and translation word pairs in unmasked lexical decision task. Significant translation priming was found in translation pairs of words in both language directions; semantic priming effect was found in direction from dominant to less dominant language. Experiment 2 employed masked semantic and translation priming word pairs. Significant translation priming effect was found in both language direction, but no significant semantic priming effects were revealed. The result of Experiment 1 showed priming asymmetry, but participants' language history data revealed that for bilinguals L2 (English) was a dominant language at the moment when the series of experiments have been conducted. It was suggested that L2 can become dominant language due to social changes and these findings were taken into account. Thus, revised hierarchical model predicts priming asymmetry, since there is less semantic information accessed by L2 the magnitude of semantic priming in L2-L1 direction will be lower in comparison to the size of priming effect in L1-L2 language direction. However, Experiment 1 showed that dominance shift is possible and that the strength of the links between L1 or L2 and conceptual store may vary. Taking these findings into consideration, Altarriba (2000) suggests that psycholinguistic models of bilingual memory have to be dynamic. As reported above, in Experiment 2, Altarriba and Basnight-Brown (2007) didn't find a semantic priming effect, but only a translation priming effect. The authors explained this by suggesting that bilinguals relied solely on a lexical level of language processing; particularly, it can be a case for those bilingual speakers who are less proficient in L2.

However, it is important to emphasise that in the semantic priming experiment described above the lexical decision task was used. Thus one can argue that cognitive mechanisms involved in lexical decision task differ from the mechanism of natural reading that cannot be simplified by a choice of the reader if they see a word or a non-word (Seidenberg and McClelland, 1989). Hence, for the purpose of this research a word-naming task has been chosen to investigate semantic priming relationships of L1 and L2 in bilingual mind.

The semantic priming effect has been employed to investigate a number of bilingual studies using naming experiments. The principle lies in the task to name the target word in one language (L1 or L2) when the prime was in the other language (L2 or L1) under related and unrelated conditions in between-language experiments. For example, the English prime word cat followed by the target word in Spanish gato (Basnight-Brown and Altarriba, 2007) allows to measure priming effect in both L1-L2 and L2-L1 directions. It has been suggested that methodologically the conditions of the experiments have to be controlled on various linguistic levels (Balota and Chumbley, 1984, 1985). Historically, semantic priming naming tasks took into account different linguistic and methodological features (e.g. frequency effect in studies of Balota and Chumbley, 1984, 1985; fluency level in Altarriba and Basnight-Brown, 2007). Altarriba and Basnight-Brown (2007) note that most of the between-language studies that employed semantic priming paradigm (Chen and Ng, 1989; Frenck and Pynte, 1987) have exposed discrepancies caused by methodological variations.

For example, some of the studies showed significant priming effect in between languages (e.g. Keatley and de Gelder, 1992, Experiment 1) while others did not reveal any significant differences (e.g. Grainger and Beauvillain, 1988). Some of the studies showed incomplete picture representing semantic priming experiment only in one (L1 to L2 or L2 to L1) direction (see Altarriba and Basnight-Brown, 2007 for a complete listing). There is a probability that a wide range of results in bilingual semantic priming studies can be caused by the fact that different types of bilingual speakers have been taken part in the experiments. For the purpose of this report, the focus will be primarily on the between-language studies which take into account the language fluency or proficiency of bilingual Russian (L1) – English (L2) participants.

L2 Proficiency and Other Variables in Semantic Priming Experiments

Proficiency in L2 has been considered as an extraneous variable which influences the outcome of bilingual research on semantic priming. The general assumption is that bilinguals who are proficient in both languages would show a larger semantic priming effect than those who are not (Basnight-Brown and Altarriba, 2007). Age and order of acquisition of L2 also play important role in semantic priming and can influence the magnitude of priming (Altarriba and Basnight-Brown, 2007). However, the early work of Frenck and Pynte (1987) showed no semantic priming effect in a group of proficient English-French bilinguals, when less skilled speakers revealed significant semantic priming effect. In other studies bilinguals were speaking both of their languages from early childhood, e.g. French (L1) – Dutch (L2) speakers and Chinese (L1) – English (L2) speakers (Keatley and de Gelder, 1994) and Hebrew (L1) – English (L2) speakers (Tzelgov and Eben-Ezra, 1992). For example, Tzelgov and Eben-Ezra (1992) found equally strong facilitation within and between-languages. Evidence from Keatley and colleagues (1994) study supported separate store model and showed greater semantic priming effect in L1-L2 condition.

Meanwhile some researchers recruited bilingual speakers who acquired L2 around adolescence, such as Chinese (L1) – English (L2) speakers in the study of Chen and Ng (1989) who showed semantic priming effect in both within and between-languages. However, in other studies bilingual speakers learnt their second language during adulthood (Williams, 1994). Also, important to note that in some studies questionnaires were used to reveal participants' proficiency level, that could lead to subjectivity when participants either over- or underestimated their language skills (Basnight-Brown and Altarriba, 2007). That is why language writing or reading test, such as Schonell Reading Test (1971) can help researcher to avoid subjectivity when scoring participant's level of language proficiency and to select for the experiment those participants who are equally proficient.

Psycholinguistic variables: Word Frequency and Length

Moreover, it is very important to control for psycholinguistic variables such as word frequency and word length in between-language experiments as they can influence the magnitude of semantic priming. Ideally semantic priming experiments ought to be controled for word frequency and length control, this is not always the case, particularly taking into account the major differences that exist between writing systems (Basnight-Brown and Altarriba, 2007). Chen and Ng (1989) specifically stated that the control over word length was not possible in their study due to the fact that Chinese characters versus English alphabetic writing system were used. Others noted that their attempt to control word length was partially successful (Schwanenflugel and Rey, 1986). The same can be said about the current report as the average length of English words is 1.4 syllables compared to 3 syllables in Russian where words are almost twice longer (Friedberg, 1997). Hence, even if an attempt has been made to choose words of equal length in both languages this is only partially fulfilled in naming tasks.

Stimulus Onset Asynchrony (SOA)

Other methodological factors such as the Stimulus Onset Asynchrony (SOA), that is the duration of presentation, can influence the strategy participants use and affect the magnitude of semantic priming (Altarriba and Basnight-Brown, 2007). Even if studies typically use an SOA of 200-300ms, a number of studies report using longer SOA of 500 ms and still revealed significant semantic priming effect (Tzeglov and Eben-Ezra, 1992; Williams, 1994). It is suggested that longer SOA gives participants time to translate primes in their first language which could eliminate automatic processing and influence accuracy of L2 to L1 translation. Some studies used both long and short SOA to learn if these manipulations would influence semantic priming magnitude and if any difference will be found. Grainger and Beauvillain (1988) used this design for their study and found semantic priming effect only for long SOA in L2 to L1 direction. Meanwhile, Keatley, Spinks and de Gelder (1994) did not find any significant effects for both directions either under long nor short SOAs, whereas, Tzeglov and Eben-Ezra (1992) found robust semantic priming effects under both conditions and for both language directions. This wide range of the results shows how difficult it is to make it clear what role SOA plays in semantic language processing.

To sum it up, as can be seen from the methodological issues raised in this Chapter there are crucial methodological factors that influence semantic priming across languages and needed to be taken into account for further between-language studies, such as: language proficiency in L2 and language dominance, age of acquisition and frequency of the words used as stimuli. When semantic priming effects are reported under between-language conditions only (e.g., L1–L2 or L2–L1) they are assumed to be problematic and to represent only ‘half of the picture’ and (Altarriba and Basnight-Brown, 2007). This can be corrected by including within-language conditions to ensure that the stimuli produce priming.

Another variable which has been reported to affect semantic priming along with bilingual level of proficiency is semantic characteristic or properties of words. For example, some studies showed that concrete words in comparison to abstract words were faster translated and showed greater priming effect (e.g., de Groot, Dannenburg, and van Hell, 1994; Schoonbaert et al., 2009). The number of translations is another variable, according which the word with one translation meaning in both languages is less language depended than word with several meanings. Thus it can be assumed that the semantic priming effect is greater if words between languages share a semantic relationship. The research of Sanchez-Casas et al. (2006) described above fully illustrate this conception. Kotz and colleague (2001, 2004) tested semantic and associative relations separately. The research on only semantically related words versus associated words in lexical decision task showed a significant priming effect for associated words (Kotz and Elston-Guttler, 2004). However, when Kotz (2001) tested early bilinguals, evidence for both associative and semantic relationships was found. Kotz's research demonstrated that not only the level of fluency, but the age of L2 acquisition might influence semantic priming effect in bilinguals. It is therefore important to control for variables such as proficiency when conducting between-language experiments.

Experiments 4 and 5 will focus on examining the implications of semantic priming when the prime and target are between-language s, i.e. either in L1 and L2 or L2 and L1, in order to provide a comprehensive account of semantic processing in Russian (L1) - English (L2) bilinguals. Experiment 4 will examine between-language priming where primes will be presented in Russian (L1) and targets in English (L2) under related [врач doctor - nurse] and unrelated [врач doctor - cat] prime-target word pair conditions. In Experiment 5, the primes will be in English (L2) and targets in Russian (L1) under related [doctor - медсестра nurse] and unrelated prime-target word pairs [doctor - кошка cat]. Participants's fluency in L2 will be measured using the objective Schonell reading test (1971). According to the predictions of the RHM (Kroll and Stewart, 1994) the priming from L1 to L2 will be larger than from L2 to L1 and will be taken as evidence for interconnected stores between L1 and L2 where the strength of representations between L1 and L2 are determined by proficiency in L2. The fluency of the bilingual participants in L2 will be taken into an account and the findings will enable the development of a theoretical understanding of semantic processing in bilingual Russian (L1) - English (L2) speakers.

However, as noted in this Chapter, there are a variety of results of the between-language studies on the role of language direction and orthographical manipulation in language processing influenced by the methodological differences. One of the major questions within between-language studies is what role orthography plays in semantic priming? Will significant differences be found if orthographic manipulation have place in both L1-L2 and L2-L1 direction? Is semantic priming powerful enough not to be influenced by orthographic manipulations? Recent studies confirmed that a number of factors influence results of word-naming tasks on both semantic and lexical levels (Liu, Shu and Li, 2007). It was proved that in between-language studies where two different languages are directly compared orthography plays important role in word-naming (e.g., Katz and Frost, 1992; Balota et al., 2004; Barca, Burani, and Arduino, 2002 and others).

The next Section focuses on evaluating the role of orthography in lexico-semantic processing.

The role of orthography in bilingual research: Orthographic manipulation of L1 and L2

A review of the literature showed that little research has been conducted to examine the role of orthographic manipulation between a bilingual's two languages. One exception is the study by Akamatsu (1999) who used case alternation (i.e., cAsE aLtErNaTiOn; see Baron and Strawson, 1976; Besner, 1983, 1989; Besner, Davelaar, Alcott, and Parry, 1984; Besner and McCann, 1987 for details) to visually distort orthographic representation in order to investigate the effects of L1 (alphabetic; Persian versus non-alphabetic: Chinese, Japanese) orthographic characteristics on word recognition in English (L2) in a naming task. It was predicted that 'although visually distorted words have lost word-shape cues, they preserve the cue value of words (i.e., spelling patterns)' (Akamatsu, 1999, p. 381) that the visual distortion should not influence naming if participants were proficient in dealing and sensitive to an alphabetic orthography. Akamatsu (1999) reported that the 'magnitude of the case alternation effect in a naming task was significantly larger for the ESL (L2) participants whose L1 is not alphabetic (i.e., Chinese and Japanese) than the ESL participants whose L1 is alphabetic (i.e., Persian).' (Akamatsu, 1999, p. 381). This was taken as evidence that the nature of L1 orthography influences visual word recognition in L2.

One of the few studies that explored the role of orthographic manipulation on bilingual language processing in semantic priming employed words and nonwords, that is, orthographically novel items (Masson and Isaak, 1999). It was found that '…primes can enhance target identification by contributing to the construction of an orthographic or a phonological representation of the target, regardless of the target's lexical status' (Masson and Isaak, 1999, p1). In other words priming takes place irrespective whether the prime is a word or a nonword. It must be noted here that although the authors employed a naming task they nevertheless used masked repetition priming in which the prime and target are the same (e.g. salt and SALT respectively).

The rationale of Experiments 6-9 reported in this thesis follow a similar logic but is fundamentally different in that the aim is to create orthographic conditions which are either congruent (L1 O1; L2 O2) or incongruent (novel) (L1 O2; L2 O1) for Russian (L1) - English (L2) bilinguals using the semantic priming paradigm. The aim of Experiments 6-9 is to examine what role, if any, the role of orthography, i.e. lexical processing, has on priming in Russian (L1) - English (L2) bilinguals. For the purpose of these experiments the unique characteristics of Russian orthography which uses both Cyrillic and Roman letters (see Table 1 for details) will be manipulated to create words that are either purely Cyrillic or Roman letters that will be presented under within and between orthography conditions as described below. The objective is to examine the extent to which between-language interference occurs not just at the semantic but also at the lexical level of language processing.

Experimental conditions as described below have been designed to explore between-orthography interference in Russian (L1)- English (L2) bilinguals as follows:

Experiment 6

i. Participants will be asked to name Russian target words when the prime is a related English word transcribed in Russian, e.g. брэд /bread/ - масло butter. (Henceforth transcribed words will be presented between two forward slash signs e.g. /bread/).

ii. Participants will be asked to name Russian target words when the prime is an unrelated English word transcribed in Russian, e.g. батер /butter/ - стол table

Experiment 7

iii. Participants will be asked to name related English target words transcribed in Russian when the prime is a Russian word, e.g. врач doctor - нерс /nurse/.

iv. Participants will be asked to name unrelated English target words transcribed in Russian when the prime is a Russian word, e.g. медсестра nurse - кэт /cat/.

Experiment 8

v. Participants will be asked to name related Russian target words transcribed in English when the prime was an English word, e.g. bread - maslo batter.

vi. Participants will be asked to name unrelated Russian target words transcribed in English when the prime was an English word, e.g. chair - hleb bread.

Experiment 9

vii. Participants will be asked to name related English target words when the prime is a Russian word transcribed in English, e.g. koshka cat - dog.

viii. Participants will be asked to name unrelated English target words when the prime is a Russian word transcribed in English, e.g. medsestra nurse - cat.

The findings will be compared to the results from Experiments 1-5 when prime-target conditions were presented in orthography congruent conditions to evaluate the role of within versus between orthography manipulations.

There is a lack of literature reported to the date on between-language semantic priming which manipulates orthographic representation using the characteristics of L1 and L2. The finding from orthographic manipulation experiments will be compared to the results from between-language Experiments 4 and 5 when prime-target conditions were presented in orthography congruent conditions to evaluate the role of within versus between orthography manipulations. These finding will help to answer the question to what extent orthography influence the semantic priming effect.

Context or List Effects: Strategic control in Experimental Blocks

The particular was stimuli are organised have been demonstrated to influence the behavioural outcome in experiments designed to measure lexical and semantic processing. The notion that readers can exercise some control, thus flexibility, over the use of the two routes (i.e. either lexical or nonlexical route, see Fig. 1) according to list type came about as a result of comparing responses to pure lists which consist of only one type of stimuli (e.g. either high frequency or low frequency items) and mixed lists (e.g. high and low frequency items randomly mixed). Historically, Frederiksen and Kroll (1976) are reported to be the first to investigate the role of type of stimuli in experimental blocks on RTs in single-word naming. Frederiksen and Kroll (1976) proposed that if the lexical route is used to name words and the nonlexical route is used to name nonwords, by providing conditions that maximise their use should yield differences in RTs. That is, a pure-block condition whereby the stimuli consist of one type only, such as words, should enhance the use of the lexical route. In a mixed-block which comprises of at least two types of stimuli, words and nonwords, the sole use of the lexical route would be redundant because nonwords can only be named by the nonlexical route. It was reported that type of blocking indeed had an impact on naming latencies, such that responses in the pure-block condition were faster than the mixed condition even for nonwords. The systematic differences observed in the pure vs. mixed-blocks were attributed to possible changes in strategies, i.e. lexical vs. nonlexical, a reader may adopt under task demands (see Lupker, Brown and Colombo, 1997 for a review on context effects). Studies on other languages such as Persian (Baluch and Besner, 1991) and Turkish (Raman, Baluch and Besner, 2004) have also yielded similar results.

It is therefore important to design experimental conditions for Experiments 10 and 11 in which monolingual Russian and bilingual Russian (L1) – English (L2) speakers will be asked to recall pictures or picture names (words) in order to address one of the central questions in this research programme, that is, how memory is organised.

Free recall task

One of the popular methods of measuring episodic memory is to ask participants to look at the list of the words presented one by one in their L1 or L2 and to recall as many as they can in any order. This method is called free recall task. The free recall may include spoken or written form. The words or images can be presented in pure or mixed-block condition.

Free recall test has been employed in a number of bilingual studies in order to explore the role of episodic memory in language processing. One of early free recall task studies was conducted by Lambert and colleagues (1968) on English (L1) – French (L2) and English (L1) – Russian (L2) participants. Bilingual speakers were presented with either a pure-block (particular semantic categories were in one language while other categories were in the other language) and a mixed-block of words (within a category items were drawn from both languages). The results showed that bilingual nature of mixed list does not interfere with the recall of the words from different categories, but can disrupt recall of the words from the same category. Later on Glanzer and Duarte (1971) used the free recall task to explore English (L1) – Spanish (L2) bilinguals' memory under within and between-language conditions. Participants had to recall words either in the same language (within-language repetitions) they saw them presented or they were asked to translate the words in the opposite language (between-language repetitions) then recall them. Glanzer and Duarte (1971) reported that between-language repetition showed a higher recall score than within-language repetition. Similarly, Tulving and Colotla (1970) conducted an experiment with bilinguals and trilinguals; proficient English, French and Spanish speakers had to recall words in one, two or three of their languages. Overall, in within-language manipulations free recall in English had the highest scores followed by French and finally by Spanish. The findings were taken to indicate that each of the languages exist in relative isolation from each other. This led to assumption that languages are stored in separate, language dependent stores. On the contrary, a study on Arabic (L1) – English (L2) bilinguals confirmed the idea that lexical organisation of words is language independent as participants were better recalling words under within-language condition than in between-language (Liepmann and Saegert, 1974).

Later it was noted that recall correlates closely with a number of psycholinguistic characteristics and it was expected that age of acquisition can be related with the recall process: words acquired earlier were overall better to recall than those acquired later (Carroll and White, 1973; Gilhooly and Gilhooly, 1979; Morris, 1981). Paivio also (1976) has reported that recall correlates negatively with age of acquisition. One of the primary sources of reference when discussing the AoA effect in free recall tasks in monolingual speakers is

Dewhurst et al (1998) and Raman et al (2015) which will be discussed in detail under Chapter 7.

To the researcher's best knowledge there are no studies exploring AoA effects and free recall in Russian (L1) – English (L2) bilinguals. The current research programme is the first to investigate the role of AoA in a series of free recall tasks using pictures and their names (words) in L1 an L2 as discussed in detail under Chapter 7. Furthermore, list effects will also be examined to investigate whether free recall is under strategic control of participants.

To conclude, while a review of the literature demonstrated the variety of experimental tasks undertaken to examine lexico-semantic processes in bilinguals, it has also helped to identify that the most appropriate tasks for the Russian (L) – English (L2) bilinguals, namely the naming task in semantic priming and the free recall task.

5. Chapter 5: Russian Orthography and its Importance in Psycholinguistic Research

Preface

The aim of this Chapter is to provide a review of the Russian orthography and language and some of the historical developments that has led to the current status of the alphabet. More importantly, the distinct features of the orthography will be discussed in relation to the aims of this research programme.

A Brief History of the Russian Orthography

Modern Russian is a widely spoken East Slavic language which belongs to the Indo-European family of languages. Estimates of the number of people who speak Russian as either a first or second language vary from 285 million speakers (Weber, 1997) to 455 million (Crystal, 2008). Russian is one of the six official languages of the United Nations.

The modern Russian alphabet is based on the Cyrillic alphabet and consists of 33 letters; 21 consonants, 10 vowels and 2 silent letters (Iliev, 2013). Details of the alphabet together with letters, their names and approximate sounds in English are reported below in Table 1. The relationship between the letters of the alphabet and pronunciation in modern Russian is not phonological. Both derivational and inflectional morphologies are extremely rich. Derivation occurs primarily by means of prefixation and suffixation.

Historically there have been several attempts to change the orthography which was originally based on the ancient Greek alphabet where the aim was to translate religious Greek texts into the Slavic language. By the order of the Byzantine Emperor Michael III at around 863 AD, brothers Cyril and Methodius from Thessaloniki created a new script called

Glagolitic that originally contained 24 letters of Greek alphabet and 19 letters specific to the Slavic language (Iliev, 2013). Thus, the modern Russian alphabet is derived from the Old Slavic Cyrillic alphabet, which was borrowed from the Bulgarian Cyrillic and became widespread in ancient Russia. At that time, Russian alphabet consisted of 43 letters. Later, 4 new letters were added, 14 letters were at different times excluded as unnecessary (Barhudarov and Dosicheva, 1940; Iliev, 2013).

One of the earliest works on the theory of Russian orthography is a book by Trediakovsky (1748; cited in Ivanova, 1976), who sets out the principles of the alphabet and spelling. Lomonosov (1755; cited in Ivanova, 1976) published a seminal book called 'Russian grammar' describing rules and fundamental principles of the language, such as features of morphology and pronunciation.

In 1904 the Academy of Sciences set up a special commission of spelling which was employed in preparation of Spelling Reform. The final draft of the Reform was issued in 1912 and the proposed changes were implemented in 1918. As a result of the reform, letters Ѣ (yat), Ѳ (fita), Ѵ (ijica), i (i desyaterichnoe), Ъ (in the end of the words) were removed. In 1956, the rules of spelling and punctuation were established for the use of the letter ё (yo) (Grigoreva, 2004).

The Russian orthography is a system of rules that determine the uniformity of words and grammar forms in writing (McArthur, 1998). The modern Russian orthography rules of spelling and punctuation were approved in 1956 by the Academy of Sciences of the USSR, the USSR Ministry of Higher Education and the Ministry of Education of the RSFSR. The main principle of modern spelling of the Russian language is the morphological principle, e.g. the smallest unit for meaning is a significant part of a word (root, prefix, suffix, ending). Although, the pronunciation of the sounds is indicated in the morpheme, this is nevertheless a modifiable entity (Kresin, Bernard, Stone and Polinsky, 1996).

Table 1: Russian (Cyrillic) Alphabet

Letter	Name	Letter Sound	Approx English sound in bold	Russian example, Romanization, meaning
Аа	а [a]	/a/	f**a**ther	**а**н**а**н**а**с – "**a**n**a**n**a**s" - pineapple
Бб	бэ [bɛ]	/b/ or /bʲ/	**b**ig	**б**елка – "**b**elka" – squirrel
Вв	вэ [vɛ]	/v/ or /vʲ/	**v**ase	**в**ода – "**v**oda" - water
Гг	гэ [ɡɛ]	/g/	**g**et	**г**де – "**g**de" - where
Дд	дэ [dɛ]	/d/ or /dʲ/	**d**og	**д**ень – "**d**en'"-day
Ее	е [je]	/je/, / ʲe/ /e/	**ye**llow	н**е**бо – "n**e**bo" - sky
Ёё	ё [jo]	/jo/ or/ ʲɵ/	**yo**ghurt	**ё**ж – "**yo**zh" – hedgehog
Жж	жэ [ʐɛ]	/ʐ/	trea**s**ure	**ж**ена – "**zh**ena" – wife
Зз	зэ [zɛ]	/z/ or /zʲ/	**z**one	**з**има – "**z**ima" - winter
Ии	и [i]	/i/ or / ʲi/	h**e**	**и**кра – "**i**kra" - caviar
Йй	и краткое [i ˈkratkəɪ]	/j/	bo**y**	сво**й** - "swo**i**" - my
Кк	ка [ka]	/k/ or /kʲ/	**k**eep	**к**амера – "**k**amera" - camera
Лл	эл or эль [ɛl] or [ɛlʲ]	/l/ or /lʲ/	**l**oose	**л**и**л**ия – "**l**i**l**iya" – lilly
Мм	эм [ɛm]	/m/ or/mʲ/	**m**irror	**м**есто – "**m**esto" - place
Нн	эн [ɛn]	/n/ or /ɲ/	**n**ight	**н**ебо – "**n**ebo" - sky
Оо	о [o]	/o/	c**o**re	**о**н**о** – "**o**n**o**" - it
Пп	пэ [pɛ]	/p/ or /pʲ/	**p**arrot	**п**е**п**ел – "**p**e**p**el" - ash
Рр	эр [ɛr]	/r/ or /rʲ/	rolled **r** **r**iver	**р**ыба – "**r**yba" - fish
Сс	эс [ɛs]	/s/ or /sʲ/	**s**un	**с**ело – "**s**elo" - village
Тт	тэ [tɛ]	/t/ or /tʲ/	**t**reat	**т**у**т** – "**t**oo**t**" - here
Уу	у [u]	/u/	s**oo**n	**у**ж – "**u**zh" - adder
Фф	эф [ɛf]	/f/ or /fʲ/	**f**inger	**ф**он – "**f**on" – background
Хх	ха [xa]	/x/	**h**at	**х**леб – "**h**leb" - bread
Цц	це [tsɛ]	/t͡s/	**c**elsius	**ц**апля – "**ts**aplya" – heron
Чч	че [tɕe]	/t͡ɕ/	**ch**air	**ч**ас – "**ch**as" - hour
Шш	ша [ʂa]	/ʂ/	**sh**ark	**ш**елк – "**sh**elk" - silk
Щщ	ща [ɕɕж]	/ɕɕ/	**sh**eer	**щ**ека – "**sch**eka" - cheek
Ъъ	твёрдый знак [ˈtv'ərdɨj znak]	-	Silent	об**ъ**ект – "ob**'e**kt" - object
Ыы	ы [ɨ]	[ɨ]	Ros**e**s	т**ы** – *"ty"* – you
Ьь	мягкий знак [ˈm'yagkɪj znak]	-	Silent	сем**ь** – "sem**'**" - seven
Ээ	э [ɛ]	/ɛ/	s**e**t	**э**кран – "**e**kran" - screen
Юю	ю [ju]	/ju/ or/ ʲʉ/	**u**nited	**ю**ла – "**yu**la" - whirligig
Яя	я [ja]	/ja/ or/ ʲж/	**ya**rd	**я**блоко – "**ya**bloko" - apple

Russian morphology is extremely rich and use prefixation and suffixation to generate new words. Russian language has a rich derivational (a process of forming new word from the 'root' of the existing word) and inflectional morphology (i.e. conjugation of verbs or changes in nouns, pronouns and adjectives depending on grammatical categories) which use a number of masculine and feminine, plural and singular forms, and a choice of synonyms. The derivations in language can double or even triple the length of the word. The variety of diminutive suffixes can create changes in meaning and has high out-of-vocabulary (OOV) rates which makes understanding of language harder for non-native learners of Russian language (Kerek and Niemi, 2009b).

According to Kerek and Niemi, (2009a) the structure of the Russian orthography is complicated by exceptions and hierarchy of system of rules. The complexity of the language lies in its morphology. One of the main features of the grammatical structure of the Russian language is a mandatory change in the form of words according to the gender, number and other factors, and in the formation of phrases and sentences these words has to be coordinated accordingly. The primary means of producing synthetic forms of words in the Russian language is the ending. Endings are formed by means of the form of nouns, adjectives, numerals, pronouns. In most cases, the endings turn out to be syncretic, that is expressing more than one grammatical meaning.

Despite the complex orthography, Russia has one of the highest levels of adult literacy in the world in 2009 (Huebler and Lu, 2013). There are a number of the features of Russian orthography and morphology that affect the process of literacy acquisition (Cubberley, 2002; Kornev, Rakhlin and Grigorenko, 2010). This is partly attributed to the Russian letter-sound correspondences which involve a small number of context-dependent rules which can be difficult for beginner readers. For example, the two auxiliary signs, the "soft" and "hard" signs which make the letters in words to be read in the different ways depend on the position of "soft" and "hard" signs in the word. Moreover, a number of words contain the "jotated vowels" е (je), я (ja), ю (ju), and ё (jo). These vowels [j] correspond with other letters ([e], [a], [u] and [o] respectively) after the consonants and can change palatalization of consonants and the quality of the vowel. Russian approach to reading pedagogy helps accommodate these complexities with syllable-based approach to reading (Kornev, 1995, 2003; Egorov, 2006). Russian orthography is reported to be more phonemic in comparison to English (Grigorenko, 2012) and is morphologically very complex. Phonetic modifications, consonants and a number of irregularities prevent readers to perceive a morpheme as a distinct unit (Kerek and Niemi, 2009b).

Psycholinguistic Characteristics and Research on Russian

Diversity of languages provides a platform from which their properties and characteristics of specific features can be examined in bilingual research. This has led to a large body of research in different language pairs e.g. Italian (L1) - English (L2), (Tabossi and Laghi, 1992); Russian (L1) - English (L2), (Abu-Rabia, 2001); Spanish (L1) - English (L2), (Rosselli, Ardila, Santisi, Arecco, Salvatierra and Conde, 2002); Greek (L1) - French (L2), (Voga and Grainger, 2007); Greek (L1) - English (L2), (Niolaki, Masterson and Terzopoulos, 2014). Russian language is one of the most widely used languages but research body based on the study of the Russian language is relatively small (Kerek and Niemi, 2009b). Language features that combine the complexity and regularity is what makes Russian writing system important for between-language research, particularly with English as there are shared features between Russian (Cyrillic and Roman) and English (Roman) orthographies. As can be seen in Table 2, Modern Russian alphabet is a mixture of Cyrillic and Roman orthographies and consist of 33 letters: 6 letters are orthographically and phonologically shared with English (Roman) writing system; 7 letters are orthographically shared, but phonologically unique; 14 letters are orthographically unique, but phonologically shared and finally 6 Cyrillic letters are orthographically and phonologically unique.

The increased world-wide use of Russian along with the wave of immigration of the Russian-speaking population in the last 20 years makes it essential to understand the processes of being a Russian (L1) - English (L2) bilingual speaker.

One of the few psycholinguistic studies on Russian bilingual language processing is reported by Abu-Rabia (2001) where the relationship between Russian and English orthographies was tested. Participants were bilingual Russian (L1) - English (L2) speakers. They were tested on working memory, spelling, visual and phonological conditions, orthographic skills, word attack and word identification. Orthographic skills showed correlation within-languages, but not between-languages. Also, phonological and spelling skills in Russian (L1) seem to be predictors of word identification in English (L2).

Table 2: Phonological and Orthographical Representation of Cyrillic Alphabet

	Russian letter	English letter or transcription
Orthographically and Phonologically shared	Аа Ее Кк Мм Оо Тт	Aa Ee Kk Mm Oo Tt
Orthographically shared, Phonologically unique	Вв Зз Нн Рр Сс Уу Хх	Vv Zz Nn Rr Ss Uu Hh
Orthographically unique, Phonologically shared	Бб Гг Дд Жж Ёё Пп Фф Чч Ии Лл Цц Шш Ээ Юю	Bb Gg Dd (zh) (yo) Pp Ff (ch) Ii Ll Cc (sh) Ee (yu)
Orthographically unique, Phonologically unique	Йй Щщ Ыы Ьь Ъъ Яя	(y’) (sch) (y) (-) (-) (ya)

In another study, Brill and Green (2011) recruited bilingual English (L1) – Russian (L2) speakers to test whether in a Stroop test bilingual speakers ignore one language when they switch to the other language. English (L1) speakers who formally studied Russian as L2 were presented with a within-language English Stroop test and a between-language Russian Stroop test. The results showed bigger interference effect for English (L1) than for Russian (L2), while bilingual speakers demonstrated equally large interference effect for both English (L1) and Russian (L2). These results were taken as evidence to support the assumption that bilinguals access both their languages simultaneously.

Recent developments saw the emergence of the first normative data in Russian Tsaparina, Bonin and Meot (2011) using the colour version of the Snodgrass and Vanderwart (1980) pictures (Rossion and Pourtois, 2004). This set of pictures has been normed and used for research in different languages, such as Turkish (Raman, Raman and Mertan, 2014), Spanish (Sanfeliù and Fernandez, 1996), British English (Barry, Morrison, and Ellis, 1997), French (Alario and Ferrand, 1999), Icelandic (Pind, Jónsdóttir, Tryggvadóttir, and Jónsson, 2000), Italian (Nisi, Longoni, and Snodgrass, 2000), Japanese (Nishimoto, Miyawaki, Ueda, Une, and Takahashi, 2005), Chinese (Weekes, Shu, Hao, Liu, and Tan, 2007), and Modern Greek (Dimitropoulou, Duñabeitia, Blitsas, and Carreiras, 2009 and others). The colour version was successfully used in a number of psycholinguistic studies: picture-naming study in Chinese (Weekes Shu, Hao, Liu, and Tan, 2007); picture naming in English (Therriault, Yaxley, and Zwaan, 2009); norms for name agreement, AoA, and visual complexity were collected in Modern Greek (Dimitropoulou et al., 2009) and in a free-recall task in Turkish (Raman, Raman, Ikier and Kilecioglu, 2015, under review). Tsaparina and colleagues (2011) reported norms for name agreement, image agreement, conceptual familiarity, imageability, and age of acquisition in Russian. This is an important aspect especially for the purpose of Experiments 10 and 11 reported in this thesis in Chapter 7.

The word frequency counts were included in the Tsaparina et al (2011) study and were taken from the New Frequency Dictionary of Russian Vocabulary incorporating over 150 million words (Lyashevskaya and Sharov, 2008). All the participants were native Russian speakers living in St. Petersburg. In total 181 participant took part in the research, 31 of them participated in the AoA rating task. The particular interest for the current research programme is the procedure employed for the collection of AoA subjective ratings from participants. In the AoA rating task participants were asked to estimate the age they thought they learned names of the pictures presented. AoA was rated on a 5-point scale and divided into ranges of 3 years (0–3 at one extreme and 12+ at the other). The values were then converted to numerical values, with 1 = learned between 0–3 years and 5 = learned at age 12 or after. The obtained normative database for pictorial material is useful for further research in memory, language production and language processing in adult Russian speakers. Particularly, the normative data for age of acquisition in Russian was employed for the current research programme as reported in Chapter 7.

Most recently a new normative database consisting of 375 action pictures and related verbs has been reported in Russian (Akinina, Malyutina, Ivanova, Iskra, Mannova and Dragoy, 2015). The stimuli were controlled for name agreement, objective and subjective visual complexity, image agreement, imageability, familiarity, age of acquisition, verb lemma frequency, number of arguments present in the picture, word length in syllables (in the third-person and infinitive forms), instrumentality, and name relatedness. The results obtained from Russian native speakers are highly consistent with those reported in other languages (verb database) apart from the finding of higher naming disagreement in Russian which can be explained by complicated morphology of the language (Akinina et al., 2015).

To conclude, a review of the literature on experimental research attempting to understand the cognitive processes of Russian monolingual as well as bilingual speakers showed that this is still in its infancy. Russian presents a unique orthography which will be employed for the first time to address the research questions raised in the current programme with the purpose of establishing a theoretical account of the architecture of lexical and semantic processes in monolingual Russian and bilingual Russian (L1) - English (L2) speakers, as well as memory, using experimental paradigms such as naming tasks and free recall tasks explained in detail in relevant chapters.

6. Semantic Priming in Monolingual Russian Speakers and Bilingual Russian (L1) - English (L2) Speakers in a Single Word Naming Task [1]

Preface

The aim of this Chapter is to report a series of semantic priming experiments using a naming task which employed both monolingual Russian speakers and bilingual Russian (L1) - English (L2) speakers. Some of the methodological issues, such as masked versus visible priming, are also addressed in the following Section in order to justify the rationale that underpin the set of semantic priming experiments reported in this Chapter.

A Methodological Concern: Masked versus Visible Semantic Priming

As reported in Chapter 4, Section 4, between-language semantic priming tasks typically employ masked primes with short SOAs. The implications of a significant priming effect are taken to indicate an automatic mechanism when masked primes are used (see Section 4.4 for a theoretical review of mechanisms involved in semantic priming). Decades of research on the topic has led to general consensus that mechanisms involved in semantic priming is closely related to whether primes are masked or visible to participants. The masked priming is an effective technique for examination of automatic processing involved in visual recognition (Forster, 1998; Forster and Davis, 1984; Forster, Mohan, and Hector, 2003; see also Dehaene et al., 1998; Grainger, 2008). The masked priming is the term which refers to the technique when the prime word is hidden behind symbols, such as ######.

A part of this chapter has been submitted for publication, co-authored by Ilhan Raman and Bahman Baluch

The prime can be masked in forward manner (the ###### symbol is presented before the prime) or backward manner (after the prime). The prime is also presented for a very short period of time (less than 80ms). These manipulations with priming presentation lead to activation of automatic, but not attentional mechanism of semantic priming; hence the participants' ability to make attentional decision is eliminated. The studies showed that even when the participants are unaware of the presence of the masked prime, they can still produce activation via word identification system. That means that semantic information can be accessed without full conscious awareness of the items' existence (Allport, 1977; Marcel, 1983). However, the masked priming experiments have been criticised by a number of researchers (Ellis and Marshall, 1978; Williams and Parkin, 1980; Holender, 1986). It is questioned if the information presented under masked condition is not reaching conscious level. Also, it is unclear if the meaning-related information received without conscious analysis can be identified appropriately to the extant when semantic processing is fully activated (Holender, 1986). Neuroimaging and behavioural studies showed that masked priming and visible semantic priming involve quite different processes in the brain. For example, fMRI studies showed that visible priming involves global conscious access, while in masked priming processing is narrowed to unconscious processes (Kouider, Dehaene, Jobert and Le Bihan, 2007). Hence, it can be assumed that visible semantic priming reflects that processes involved in normal reading better than masked priming.

Based on the review on masked versus visible priming above, the experimental procedure for Experiments 1-9 followed the rationale of presenting participants with a visible prime for 500ms as it was important to create experimental settings as close to real life practices in naming words. Participants were given 1000ms deadline to respond to the subsequent target. Given the lack of semantic priming reports for Russian in the literature, the starting point for the research programme was to establish semantic priming effect in naming for monolingual Russian adults.

Within-language semantic priming in monolingual Russian speakers and bilingual Russian (L1)- English (L2) speakers: Experiments 1, 2 and 3

The aim of Chapter 6 is to report the first set of experiments that aimed to examine within-language semantic priming in monolingual Russian (L1) and bilingual Russian (L1) - English (L2) speakers in naming. As reported under Chapters 1 and 3, recent bilingual psycholinguistic studies focus on two key issues (e.g. Desmet and Duyck, 2007; Dijkstra and Van Heuven, 2002; Brysbaert et al, 2014). The first is related to the storage and the organisation of the two languages, that is, if L1 and L2 are stored in the same memory location or in two different locations. The second major issue is related to mental capacities that are required to process both languages. More specifically, what cognitive process are involved in the practice of reading, writing and speaking L1 and L2, and in understanding and responding in two languages (Jared and Kroll, 2001)?

The Rationale

As reviewed in Chapter 3, the semantic priming paradigm is an ideal experimental method to examine how the two languages of a bilingual are organised, i.e. whether they are stored in a single or two separate lexicons (e.g., Kroll, van Hell, Tokowicz and Green, 2010). It was argued that bilingual research into the Russian orthography represents a novel medium that could help answer these questions. A review of the literature in Chapter 5 indicated that little is known about lexical and semantic processing in Russian as well as the organisation of the mental lexicon (Kerek and Niemi, 2009a; 2009b; Tsaparina et al, 2011). In this respect, there are currently no theoretical models that offer an explanation in view of the cognitive processes involved in reading Russian and the organisation of the mental lexicon.

A series of semantic priming experiments were designed to address empirical questions raised in the literature (see Table 3 for a summary of experimental design for Experiments 1-3)

Table 3: Summary of experimental design for Experiments 1-3

Participants	***Related***		***Unrelated***
Experiment 1 Monolingual Russian (L1)	Russian prime Врач (*doctor*)	Russian target Медсестра (*nurse*)	Russian prime Хлеб (*bread*)
Experiment 2 Bilingual *Within-lang* L1-L1	Russian prime Врач (*doctor*)	Russian target Медсестра (*nurse*)	Russian prime Хлеб (*bread*)
Experiment 3 Bilingual *Within-lang* L2-L2	English prime Car	English target Bus	English prime Tablet

Experiment 1

Design

In a repeated measures design, monolingual Russian participants were required to name target words under related and unrelated prime-target experimental conditions. The naming RTs (ms) and errors were recorded.

Participants

A total of 20 adult monolingual Russian speaking students from St-Petersburg State Paediatric Medical University, St. Petersburg, Russia, took part in Experiment 1. All the participants were monolingual Russian speakers with normal or corrected to normal vision, 14 women and 6 men, 17-22 years old (mean age 19.3).

Materials

Care was taken to use only very common or frequent words because a variation in word frequency has been reported to influence the semantic priming outcomes (see Lemhöfer et al, 2008 for a review) therefore word frequencies were taken from the Word Frequencies Dictionary of modern Russian language which was based on a collection of texts of the Russian National Corpus, representing the modern Russian language for the period of 1950-2007 (Lyashevskaya and Sharov, 2009).

Materials comprised of either 21 semantically related pairs [врач - медсестра (*nurse*)] and [собака (*dog*)-кошка (*cat*)] or 21 unrelated pairs [врач (*doctor*) – кошка(*cat*)] which were presented using SuperLab software (see Appendix 2 for a full set of stimuli in Russian together with corresponding translations in English).

Details of equipment

SuperLab-5 software was used to create series of Semantic Priming word naming experiments. Along with SuperLab-5 software the SV-1 box was employed to record reaction time (RT) in word naming. SV-1 is a voice key device equipped with microphone and headset which acquire vocal reaction times. SV-1 was designed specifically for experiments requiring a vocal response. SV-1 monitors the participant's voice level at all time, and when the level rises above a user-specified threshold, it reports this to the computer. In Experiment 1 SuperLab-5 presented participants with semantically related or unrelated pairs of words in Russian only and SV-1 box recorded reaction time when participants named the target words. The experimenter controlled and registered if any voice recording errors (e.g. caugh, etc) accrued.

Ethical approval

The study commenced after ethical approved was granted by the Psychology Ethics Committee at Middlesex University and permission was given by the St. Petersburg State Paediatric Medical University. Participants were tested one by one in a single session after giving informed consent in a quiet room located at the Department of Clinical Psychology, at St. Petersburg State Paediatric Medical University.

Procedure

A practice trial of 4 primes and 4 targets were run to familiarize participants with the procedure and the equipment. The participants were tested one at a time in a quiet laboratory at St.-Petersburg State Paediatric Medical University and were seated approximately 60 cm from a computer screen and instructed to name the target words as quickly and as accurately as possible.

SuperLab experiment generator was used to present the stimuli and to record naming RTs via an SV-1 voicebox. First, a fixation point was presented on the computer for 500ms, followed by a 250ms blank, and then by the prime word in black font size 18 against white background in the middle of the screen for the next 500ms. The target followed the prime on the screen and disappeared after a response was made or after a 1000ms deadline to respond before the next trial began. If participants did not name the target within the deadline, this was recorded as NR (no response). Finally, the related and unrelated conditions were counterbalanced to prevent order effects. The participants' number of errors was recorded by the experimenter.

Results

Data were analysed using descriptive statistics (see Table 4) and a repeated measures t-test. The SD values similar indicating homogeneity of variance. A difference of 25ms between related and unrelated conditions was found to be statistically significant. The results showed a significant semantic priming effect for monolingual Russian speakers, $t(19) = 2.6$, $p<0.01$, $d=0.53$. The error rates were less than 1% and therefore were not entered into analyses.

Table 4: Descriptive statistics showing naming RTs in milliseconds and SD in related and unrelated prime-target conditions in Experiment 1 for Russian monolinguals

Experimental Condition in Russian	Mean RTs	SD
Related	515	49
Unrelated	540	44
Magnitude of semantic priming	25	

Interim Discussion

The aim of Experiment 1 was to establish the existence of semantic priming effects in native Russian speakers in a naming task. As can be seen from the results reported above, a significant semantic priming effect is reported here for the first time in Russian adds to the body of literature in different languages. This was predicted by automatic spread of semantic network activation (Collins and Quillian, 1969) hypothesis and is taken to further support the universality of this phenomenon in the human mind irrespective of language.

Armed with this result, the focus turns to Experiments 2 and 3 in an attempt to examine within-language semantic priming in Russian (L1) - English (L2) bilinguals. This query is in line with the current trends in bilingual research as discussed extensively under Section 4.4.3 of this thesis.

Experiment 2

Method

Experiment 2 was a replication of Experiment 1 in which 20 bilingual Russian (L1) - English (L2) speaking university students were recruited from Middlesex University, London. A total 12 women and 8 men at age 20-25 (mean age 21.8) took part in the Experiment 2. The participants were required to respond to the same stimuli as in Experiment 1 in Russian (L1) and were tested one at the time in a laboratory setting at Middlesex University using SupeLab software and SV-1 voice box. Naming RTs and errors were recoded the same way. All the participants were native Russian (L1) speakers highly proficient in English (L2), who moved to the UK no longer than 5 years ago and use both Russian (L1) and English (L2) on every day basis at work, studies and social interactions. English language proficiency was tested with Schonell Reading Test (1971) as will be discussed in detail below. None of participants were enrolled in the English-as-a-Second-Language program or in intensive English courses.

Details of equipment

SuperLab-5 software was used to create series of Semantic Priming word naming experiments. Along with SuperLab-5 software the SV-1 box was employed to record reaction time (RT) in word naming. SV-1 is a voice key device equipped with microphone and headset which acquire vocal reaction times. SV-1 was designed specifically for experiments requiring a vocal response. SV-1 monitors the participant’s voice level at all time, and when the level rises above a user-specified threshold, it reports this to the computer. In Experiment 2 SuperLab-5 presented participants with semantically related or unrelated pairs of words in Russian only and SV-1 box recorded reaction time when participants named the target words. The experimenter controlled and registered if any voice recording errors (e.g. cough, etc) accrued.

Ethical approval

The study commenced after ethical approved was granted by the Psychology Ethics Committee at Middlesex University and permission was given by the St. Petersburg State Paediatric Medical University. Participants were tested one by one in a single session after giving informed consent in a quiet room located at the Department of Clinical Psychology, at St. Petersburg State Paediatric Medical University.

Procedure

Three possible outcomes are predicted: i) semantic priming effect will be the same for monolingual Russian (L1) and Russian (L1)-English (L2) bilinguals ii) semantic priming effect will be smaller for Russian (L1)-English (L2) bilinguals compared to monolingual Russian (L1) and iii) semantic priming effect will be larger for Russian (L1)-English (L2) bilinguals compared to monolingual Russian (L1). It therefore follows that if i) the size of semantic priming effect is the same for monolingual Russian (L1) and bilingual Russian (L1)-English (L2) speakers, it will be taken to indicate that having semantic networks (Collins and Quillian, 1969) in two different languages does not influence spreading activation (Collins and Loftus, 1975). If ii), then it will be assumed that nontarget language L2 is activated which has a negative influence on the semantic priming effect in the target language L1. If iii), this will be taken to indicate that although nontarget language L2 is activated, it has a positive or facilitatory effect on L1 semantic priming effect. Evidence for (i) would support a two-store model where L1 and L2 are stored in semantic networks independent of each other (e.g. Potter et al, 1984). Evidence for (ii) and (iii) will be taken to indicate a common store (Paivio et al, 1988) as depicted in the RHM by Kroll and Stewart (1994), one memory store for concepts for both languages.

A major methodological and theoretical consideration in Experiment 2, is therefore the measure of objective proficiency of the Russian (L1)-English (L2) bilinguals in their L2, i.e.

in English, using the Schonell reading test (1971) (see Appendix 1). As discussed previously under Section 3.4, according to the RHM direct access to meaning in L2 strengthens with proficiency. Therefore, the more proficient a bilingual is the more reliant they become on their direct L2 conceptual link for accessing meaning according to the RHM (Kroll and Stewart, 1994, see Figure 7). A highly proficient bilingual would therefore show comparable semantic priming effects in both L1 and L2 whereas a less proficient bilingual would show a smaller or null effect for semantic priming in L2.

The procedure was the same as in Experiment 1 with the addition of the English (L2) language proficiency test using the Schonell Reading Test in English (Schonell, 1971; see Section 4.4.5 for details). The present study took objective proficiency measures into account for the first time to ascertain fluency in the two languages of the participants. Participants were asked to read words given in the test paper from left to right, from top to bottom as accurate as possible. If participants had difficulties with a pronunciation of a particular word he or she was asked to sound it out anyway. When participants were not able to say the word they were asked to go on to the next one. One mark was given for the each word correctly pronounced, even if the reader self-corrected. The researcher did not correct participants and did not suggest a pronunciation. The number of errors was measured and the test was stopped if 8 consecutive errors are made. This test had no time limit.

The number of correct words and errors were compared with a normative table given in the test. Those participants who read correctly 75% of the words and above were taken to be proficient enough in English (L2). It is important to note that all the participants who took part in Experiment 2 were proficient in their L2.

Results

Data were analysed using descriptive statistics as can be seen in Table 5 and a repeated measures t-test which showed a statistically significant priming effect, i.e. statistically significant difference between related and unrelated target words in Russian (L1) for bilingual Russian (L1) - English (L2) speakers, $t(19) = 4.04$ $p < 0.001$, $d = 0.69$. Error rates were less than 1% and therefore were not the subject of analyses.

Table 5: Descriptive statistics showing naming RTs in milliseconds and SD in related and unrelated Russian prime-target conditions in Experiment 2 for Russian (L1) - English (L2) bilinguals

Experimental condition in Russian (L1)	Mean RTs	SD
Related	522	57
Unrelated	572	85
Magnitude of semantic priming	50	

The naming RTs from Experiments 1 and 2 were further analysed using a t-test as the descriptive statistics showed a large difference between monolingual (25ms) and bilingual (50ms) semantic priming effects in Russian (L1). The results confirmed that this difference was statistically significant $t\ (19) = 2.2$, $p < 0.04$.

Interim Discussion

The findings in Experiment 2 show a magnified semantic priming effect for bilingual Russian (L1) - English (L2) speakers compared to monolingual Russian speakers and are taken to indicate that semantic activation occurs automatically where activation of both L1 and L2 in bilinguals increases the priming effect. Furthermore, this effect can only come about if the two languages are activated from a single store (Altarriba and Basnight-Brown, 2007). It is also important to note that monolingual RTs to experimental conditions in Experiment 1 were notably faster to those in Experiment 2 although in both experiments participants responded to L1 prime-L1 target conditions.

Experiment 3

The aim of Experiment 3 is to examine semantic priming in English (L2) in Russian (L1) - English (L2) bilinguals.

Method

Design

The experimental conditions were within-language in English (L2), that is, related and unrelated prime-target pairs were presented in English (L2), e.g. *doctor-cat* and *dog-nurse*, respectively. Naming RTs to target words were recorded together with errors.

Participants

The same Russian (L1) - English (L2) bilingual participants from Experiment 2 were recruited for the purpose of this experiment.

Materials and Procedure

A total of 42 trials were presented in English using SuperLab; 21 semantically related pairs (doctor-nurse, dog-cat); 21 unrelated pairs were formed by re-pairing the stimuli in the related cases (e.g., doctor-cat, dog-nurse). Word frequencies in English were taken from the Celex Lexical Database (Baayen, Piepenbrock and Van Rijn, 1993) using the combined written and spoken frequency measures of the word. The full set of stimuli used in the study can be found in Appendix 3. The procedure was the same as in Experiment 2.

Results

As can be seen from Table 3, a difference of 46ms is observed between related and unrelated prime-targets when participants name targets in English (L2). Formal analysis of data showed a significant semantic priming effect [$t\ (19) = 2.7$, $p < 0.01$, $d = 0.68$] in English (L2) for bilingual Russian (L1) - English (L2) speakers. Error rates were recorded but were too small for analyses (less than 1%).

Table 6: Descriptive statistics showing naming RTs in milliseconds and SD in related and unrelated English prime-target conditions in Experiment 3 for Russian (L1) - English (L2) bilinguals

Experimental condition in English (L2)	Mean RTs	SD
Related	602	74
Unrelated	648	59
Magnitude of semantic priming	46	

Combined analyses for Experiments 2 and 3 and Interim Discussion

Data from Experiments 2 and 3 were collapsed for analyses in order to examine the issue of storage in the bilingual memory. As highlighted previously, proficiency of bilinguals has been reported to influence the outcome of semantic priming effects (Kroll and Stewart, 1994). Schonell Reading Test (1971) was employed to the Russian (L1) - English (L2) bilingual participants who took part in both Experiments 2 and 3. It was found that proficiency in English (L2) had a significant positive correlation with the magnitude of the semantic priming effect in Russian (L1) only, $r(20)=.57$ $p< 0.009$. The correlation between proficiency in L2 and semantic priming in L2 was nonsignificant ($p>0.05$).

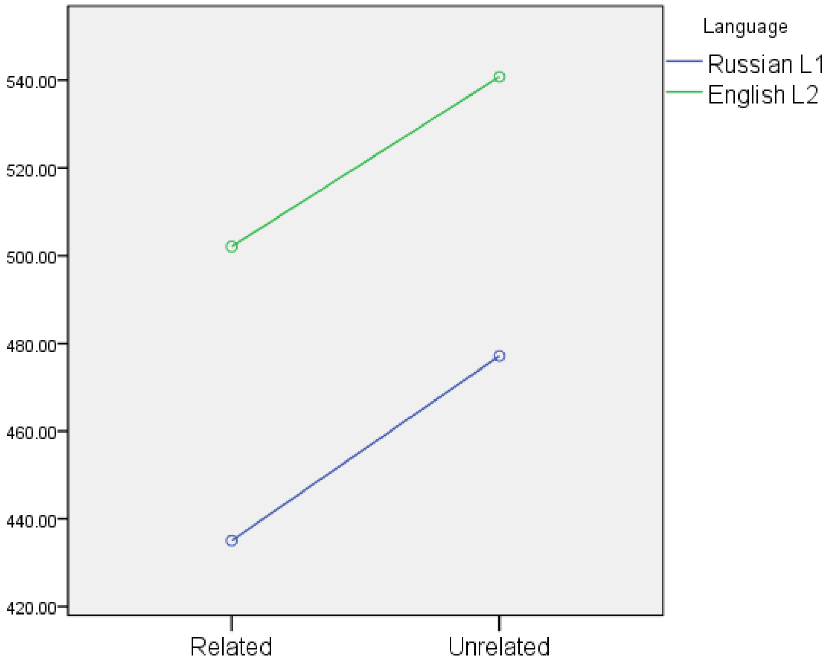

Figure 8: Naming RTs under related and unrelated conditions for Russian (L1) - English (L2) bilinguals in Experiments 2 and 3

As can be seen in Figure 8, despite showing a parallel and comparable semantic priming effect size in Russian (L1) and English (L2), Russian (L1) - English (L2) bilinguals are nevertheless slower in naming RTs in their second language English (L2) than their native language, Russian (L1). Moreover, a significant correlation was reported between proficiency in English (L2) and semantic priming effect size only in Russian (L1). This is taken as an indication of a) shared store for the two languages and b) the spreading activation where L1 and L2 are simultaneously and automatically activated thus benefiting the already strong links between L1 and their concepts according to the RHM (Kroll and Stewart, 1994).

To conclude, the current set of within-language experiments reported here provide evidence to support the claims of the bilingual RHM in that within-language effects were found for Russian (L1) - English (L2) bilingual participants in both their languages. Most importantly, the magnitude of the priming effect was found to be affected by proficiency in

L2 indicating that the two languages are interconnected and affect each other's processes and activation. This is in line with current findings from other languages (for an overview see Lemhöfer et al, 2008). It thus follows that if each of the bilinguals' languages were stored independent of each other none of these effects would have been reported. The next step of inquiry focuses on between-language semantic priming to provide a comprehensive account from a theoretical perspective.

Between-language semantic priming in bilingual Russian(L1) - English(L2) speakers: Experiments 4 and 5

Experiments 4 and 5 focus on examining the implications of semantic priming on naming when the prime and target are between-languages, i.e. either in L1 and L2 or L2 and L1, in order to provide a comprehensive account of semantic processing in Russian (L1) - English (L2) bilinguals. Experiment 4 examines between-language priming where primes will be presented in Russian (L1) and targets in English (L2) under related [врач *doctor* - nurse] and unrelated [врач *doctor* - cat] prime-target word pair conditions. In Experiment 5, the primes will be in English (L2) and targets in Russian (L1) under related [doctor - медсестра *nurse*] and unrelated prime-target word pairs [doctor - кошка *cat*]. Participants' profiency in L2 will be measured using the objective Schonell reading test (1971). According to the predictions of the RHM (Kroll and Stewart, 1994) the priming from L1 to L2 will be larger than from L2 to L1 and will be taken as evidence for interconnected stores between L1 and L2 where the strength of representations between L1 and L2 are determined by proficiency in L2. The fluency of the participants in L2 will be taken into an account and the findings from Experiments 4 and 5 will enable the development of a theoretical understanding of semantic processing in bilingual Russian (L1) - English (L2) speakers.

Armed with the findings from Experiments 1-3, the focus of this this section is to report the second set of experiments that aimed to examine between-language semantic priming in bilingual Russian (L1) - English (L2) speakers. The goal of Experiments 4 and 5 was to examine the extent to which between-language interference occurs not just at the semantic but also at the lexical level of language processing.

As reported in Chapter 3, Kroll and Stewart (1990) suggested that links between L1 and L2 words and conceptual store are asymmetrical. It is assumed that these links can be stronger or weaker depending on direction of language translation (from L1 to L2 or from L2 to L1) and language proficiency. Between-language set of Experiments 4 and 5 were designed to find an answer for the question whether the strength of semantic priming is influenced by language direction and/or language proficiency?

Experiments 4 and 5 were focused on examining the implications of semantic priming when the prime and target are between-languages, i.e. either in L1 and L2 or L2 and L1, in order to provide a comprehensive account of semantic processing in Russian (L1) - English (L2) bilinguals.

Experiment 4 examined between-language priming where primes were presented in Russian (L1) and targets in English (L2) under related [врач *doctor* - nurse] and unrelated [врач *doctor* - cat] conditions.

In Experiment 5, the primes were in English (L2) and targets in Russian (L1) under related [doctor - медсестра *nurse*] and unrelated prime-target word pairs [doctor - кошка *cat*]. Participants' fluency in L2 was measured using the objective Schonell reading test (1971). According to the RHM (Kroll and Stewart, 1994) it is predicted that the priming from L1 to L2 will be larger than from L2 to L1 and will be taken as evidence for interconnected stores between L1 and L2 where the strength of representations between L1 and L2 are determined by proficiency in L2. The more proficient the bilingual is the more minimal the difference between L1-L2 and L2-L1 priming effect will be. A summary of Experiments 4 and 5 can be seen in Table 7.

Table 7: Summary of experimental design for Experiments 4 and 5

Language direction	***Related***		***Unrelated***	
Experiment4 L1 to L2	Russian (L1) Врач (*doctor*)	English (L2) Nurse	Russian (L1) Хлеб (*bread*)	English (L2) Teacher
Experiment5 L2 to L1	English (L2) Doctor	Russian (L1) Медсестра (*nurse*)	English (L2) Bread	Russian (L1) Учитель (*teacher*)

Experiment 4

Design

In a repeated measures between-language design, participants were required to name target words under related and unrelated prime-target experimental conditions. Primes were presented in Russian (L1) and targets in English (L2). The naming RTs (ms) and errors were recorded.

Participants

A total of 20 bilingual Russian (L1) – English (L2) speaking students from St-Petersburg State Paediatric Medical University, St. Petersburg, Russia, participated in Experiment 4, 13 women and 7 men (mean age 20.5). All the participants are Russian (L1) native speakers highly proficient in English (L2). The level of proficiency was measured with

Schonell Reading Test (1971) where participants had to name words given in the test, the number of mistakes were recorded by the researcher. Only those participants who correctly named more than 75% of the words given were invited to participate further in the word naming test.

Materials

Again care was taken to use high frequency words in Russian and in English. Therefore word frequencies were taken from the Word Frequencies Dictionary of modern Russian language which was based on a collection of texts of the Russian National Corpus, representing the modern Russian language for the period of 1950-2007 (Lyashevskaya and Sharov, 2009). Word frequencies in English were taken from the Celex Lexical Database (Baayen, Piepenbrock and Van Rijn, 1993) using the combined written and spoken frequency measures of the word forms. Russian and English stimuli were selected so that to create related and unrelated prime-target pairs which were matched and balanced by frequency and length of the words. All the materials and the stimuli were used in the study are presented in the Appendix.

Materials comprised of either 21 semantically related pairs [e.g. врач (*doctor*) - nurse] and or 21 unrelated pairs [врач (*doctor*) – cat] which were presented using SuperLab software (see Appendix 3 for a full set of stimuli).

Details of equipment

SuperLab-5 software was used to create series of Semantic Priming word naming experiments. Along with SuperLab-5 software the SV-1 box was employed to record reaction time (RT) in word naming. SV-1 is a voice key device equipped with microphone and headset which acquire vocal reaction times. SV-1 was designed specifically for experiments requiring a vocal response. SV-1 monitors the participant's voice level at all time, and when the level rises above a user-specified threshold, it reports this to the computer. In Experiment 4

SuperLab-5 presented participants with semantically related or unrelated pairs of words in Russian (L1) and English (L2) and SV-1 box recorded reaction time when participants named the target words. The experimenter controlled and registered if any voice recording errors (e.g. caugh, etc) accrued.

Ethical approval

The study commenced after ethical approved was granted by the Psychology Ethics Committee at Middlesex University and permission was given by the St. Petersburg State Paediatric Medical University. Participants were tested one by one in a single session after giving informed consent in a quiet room located at the Department of Clinical Psychology, at St. Petersburg State Paediatric Medical University.

Procedure

A practice trial of 4 primes and 4 targets were run to familiarize participants with the procedure and the equipment. The participants were tested one at a time in a quiet laboratory at St-Petersburg State Paediatric Medical University and were seated approximately 60 cm from a computer screen and instructed to name the target words as quickly and as accurately as possible.

SuperLab experiment generator was used to present the stimuli and to record naming RTs via the SV-voicebox. Participants saw a fixation point in the middle of the computer screen for 500ms, followed by a 250ms blank, and then the prime word for 500ms presented in black font size 18 against white background. The target followed the prime on the screen and disappeared after a response was made or after a 1000ms deadline to respond before the next experimental trial began. Finally, the related and unrelated conditions were counterbalanced to prevent order effects. The participants' number of errors (typically less than 1%) was recorded by the experimenter.

Results

Data were analysed using descriptive statistics (see Table 8) and a repeated measures t-test showed that the size of priming (22ms) was statistically significant [t (19) =2.82 $p<0.01$, *d*=0.34].

Table 8: Descriptive statistics showing naming RTs in milliseconds and SD in related and unrelated prime-target conditions in Experiment 4

Experimental Condition L1-L2	Mean RTs	SD
Related	623	64
Unrelated	645	54
Magnitude of semantic priming	22	

Experiment 5

Design

Experiment 5 was a replication of Experiment 4 between-language design, but in Experiment 5 prime was presented in L2 (English) and target in L1 (Russian) under related and unrelated conditions.

Participants

The same Russian (L1) - English (L2) bilingual participants from Experiment 4 were recruited for the purpose of this experiment.

Materials and Procedure

The materials, equipment and procedure was also the same as in Experiment 4.

Results

Data from two participants were excluded from the final analyses in Experiment 5 due to no responses being recorded because of technical errors in the SV-1 voicebox. A repeated-measures t-test showed that naming RTs under the related condition was significantly faster than the unrelated condition, t (17) =2.41 p<0.03, *d*=0.45.

Table 9: Descriptive statistics showing naming RTs in milliseconds and SD in related and unrelated prime-target conditions in Experiment 5

Between-language experimental Condition in L2 to L1	Mean RTs	SD
Related	563	84
Unrelated	596	61
Magnitude of semantic priming	33	

Combined analyses for Experiments 4 and 5 and Interim Discussion

The data from Experiments 4 and 5 were collapsed and analysed using a 2x2 ANOVA. The findings show a significant main effect for semantic priming [$F (1, 17) = 17.07$ $p < 0.001$] and a significant main effect for language [$F (1, 17) = 7.63$ $p < 0.01$] whereby naming target stimuli was significantly faster in L1 compared to L2 (11ms difference). There was no significant interaction between the factors. Most notable however is that the *magnitude* of semantic priming in Experiments 4 and 5 is considerably different under L1-L2 (22ms) and L2-L1 (33ms) conditions. This finding is in line with the predictions of the RHM (Kroll and Stewart, 1994) but contradictory to some research previously reported in this field. For example, in a lexical decision task Keatley and Gelder (1992) reported a priming effect of only 6ms in French prime (L1) – Dutch target (L2) and -2ms (unrelated condition was faster than the related condition) in Dutch prime (L2) – French target (L1) conditions. The findings from Experiments 4 and 5 are taken to support the claim that semantic representations are shared in bilingual memory and are activated by accessing both L1 and L2 although the level of activation appears to be dependent on proficiency. The overall findings from Experiments 1-5 enabled the development of a theoretical understanding of semantic processing in monolingual Russian and bilingual Russian (L1) - English (L2) bilinguals. However, participants were required to name target stimuli in either L1 or L2 under *language-orthography congruent* conditions. In order to evaluate the involvement of orthographic representations in bilingual processing, the attention was turned to understand if semantic priming would still take place under *language-orthography incongruent* conditions as explained below.

Semantic Priming in Orthographic L1 and L2 Manipulations: Experiments 6 - 9

Experiment 6, 7, 8 and 9 were planned to examine the role of orthography, i.e. lexical processing, on language processing in Russian (L1) - English (L2) bilinguals using the semantic priming paradigm. For the purpose of these experiments the unique characteristics of Russian orthography which uses both Cyrillic and Roman letters (see Table 1 for details) were manipulated to create words that are either mostly Cyrillic or Roman letters that were presented under within and between orthography conditions as described below.

Experiments 6-9 used the same method, equipment and procedure as in previous semantic priming experiments 1-5 reported above. One crucial manipulation however was to create language-orthography congruent and incongruent stimuli (see Appendix 4 for the full set). Experimental conditions as described below have been designed to explore between-orthography interference in Russian (L1) - English (L2) bilinguals as follows:

Experiment 6

i. Participants asked to name Russian target words when the prime is a related English word transcribed in Russian, e.g. брэд /bread/ - масло *butter*. (Henceforth transcribed words will be presented between two forward slash signs e.g. /bread/).

ii. Participants asked to name Russian target words when the prime is an unrelated English word transcribed in Russian, e.g. батер /butter/ - стол *table*

Experiment 7

iii. Participants asked to name related English target words transcribed in Russian when the prime is a Russian word, e.g. врач *doctor* - нерс /nurse/.

iv. Participants asked to name unrelated English target words transcribed in Russian when the prime is a Russian word, e.g. медсестра *nurse* - кэт /cat/.

Experiment 8

v. Participants asked to name related Russian target words transcribed in English when the prime was an English word, e.g. bread - maslo *butter*.

vi. Participants asked to name unrelated Russian target words transcribed in English when the prime was an English word, e.g. chair - hleb *bread*.

Experiment 9

vii. Participants asked to name related English target words when the prime is a Russian word transcribed in English, e.g. koshka *cat* - dog.

viii. Participants asked to name unrelated English target words when the prime is a Russian word transcribed in English, e.g. medsestra *nurse* - cat.

Table 10: Experimental design and descriptive statistics showing naming RTs in milliseconds and SD (in brackets) under related and unrelated prime-target conditions in Experiments 6 and 7 using Russian orthography (L1)

	Related		**Unrelated**		**Magnitude of semantic priming**
Experiment 6	English (L2) брэд *bread*	Russian (L1) масло *butter*	English (L2) батер *butter*	Russian (L1) стол *table*	
	655 (47)		676 (36)		21ms
Experiment 7	Russian (L1) врач *doctor*	English (L2) нерс *nurse*	Russian (L1) медсестра *nurse*	English (L2) кэт cat	
	683 (39)		682 (49)		1ms

Experiments 6 and 7

A total number of 16 bilingual participants were asked to name Russian (L1) target words when the prime was a related English word transcribed in Russian, e.g. брэд /bread/ - масло *butter* and an unrelated English word transcribed in Russian, e.g. батер /butter/ - стол *table*. In the Experiment 6 total 10 female and 6 male (mean age 19.4) students of St Petersburg Pediatric Medical Academy, native Russian (L1) speakers proficient in English (L2). The level of English (L2) proficiency was measured by Schonell Reading test (1971) and only highly proficient speakers were invited to participate in word naming test. The method, equipment and procedure were the same as in the previous semantic priming experiments reported above.

As can be seen in Table 10, the magnitude of semantic priming is 21ms in Experiment 6 when target was orthography-language congruent compared to a 1ms priming effect for Experiment 7 when prime was orthography-language congruent but not the target. This appears to be in line with the prediction that it is more important for bilinguals to have orthography-language congruency at naming rather than at the prime stage. It appears that disturbance to the orthographic representations have a larger negative influence for naming targets than the prime.

In Experiment 7 a total number of 13 bilingual participants (7 women and 6 men, mean age 20.5) were asked to name related Russian (L1) target words transcribed in English when the prime was an English word, e.g. bread - maslo *butter* and unrelated Russian target words transcribed in English when the prime was an English word, e.g. chair - hleb *bread*. Participants were native Russian (L1) speakers from St Petersburg State Paediatric Medical Academy highly proficient in English (L2). Participants were selected if they successfully completed at least 75% of the Schonell Reading test (1971). The method, equipment and procedure were the same as in the previous semantic priming experiments reported above.

One relevant observation with respect to the development of the stimuli used in Experiment 8 is that since the introduction of mobile phone technology and social networks, there has been a tendency to use Romanised version of Russian words in everyday life. In this respect, one cannot assume that the incongruent orthography-language condition for target naming would eliminate a priming effect.

Table 11: Experimental design and descriptive statistics showing naming RTs in milliseconds and SD (in brackets) under related and unrelated prime-target conditions in Experiments 8 and 9 using English orthography (L2)

	Related		**Unrelated**		**Magnitude of semantic priming**
Experiment 8	English (L2) bread	Russian (L1) maslo *butter*	English (L2) chair	Russian (L1) hleb *bread*	
	627 (38)		654 (39)		27ms
Experiment 9	Russian (L1) koshka *cat*	English (L2) Dog	Russian (L1) medsestra *nurse*	English (L2) cat	
	630 (52)		643 (67)		13ms

Combined Analyses and Interim Discussion

Planned comparisons between experimental conditions showed that there was a statistically significant role of orthography-language congruency on target naming, that is when target was in O1/L1 and O2/L2, in Experiments 6 and 9 [$t(12)=0.32$ $p>0.05$, $d=0.59$]. Moreover, orthography-language congruency of prime, that is O1/L1 and O2/L2, had a significant effect on naming the target in Experiments 7 and 8 [$t(12)=2.13$ $p=0.05$, $d=1$]. None of the other comparisons between conditions yielded a significant finding. It can therefore be concluded that orthography-language congruency facilitates the semantic priming effect while noncongruency of both prime and target does not.

The collective results for Experiments 6-9 show a robust priming effect across conditions [$F(1, 152)=4.30$ $p<0.40$] together with a main effect for target orthography [$F(1, 152)=23.66$ $p<0.0001$] but not for target language [$F(1, 152)=0.93$ $p=0.34$]. None of the interactions reached significance ($p>0.05$). However, the magnitude of semantic priming varied greatly between the experiments as follows: in Experiment 6, a 21ms priming effect was observed followed by a 1.4ms effect in Experiment 7; a 27ms in Experiment 8 and a 13ms in Experiment 9. The reasons underlying the disparity of the priming effect were dıscussed previously but it is plausıble to conclude that degree the semantic representation from L1 is shared with L2 appears to be also dependent on orthographic representation. This will be further discussed under general Discussion in Chapter 8.

The series of Experiments 1-9 reported here attempted to shed light to establishing a cognitive framework in adult native monolingual Russian speakers and Russian (L1) – English (L2) bilinguals under different experimental semantic priming conditions. Based on the theoretical considerations introduced above, it can be concluded that Russian (L1) – English (L2) bilinguals develop an automated between-language links at the semantic level which are fine-tuned by level of L2 proficiency as predicted by the Revised Hierarchical Model (Kroll and Stewart, 1994). Moreover, orthographic representations appear to influence the efficiency with which one can access phonological representations to name words in L1 and L2.

7. Chapter 7: Age of Acquisition (AoA) effect in monolingual Russian speakers and bilingual Russian (L1)- English (L2) speakers in a free recall task

'Language is very difficult to put into words'.

Voltaire

Preface

The aim of the present Chapter is to provide a review of relevant research on AoA, a highly topical psycholinguistic variable, and its role in monolingual and bilingual language processing. As briefly introduced earlier in Chapter 1, AoA refers to the psycholinguistic phenomenon that early acquired items, such as words and pictures, have an advantage over late acquired items in various semantic and lexical tasks (see Johnston and Barry, 2006 for a review). Although, the role of AoA on lexical and semantic tasks is well documented and conclusive in monolinguals, the same is not true for memory tasks such as free recall. Moreover, studies thus far have been limited to English with inconclusive findings.

For the purposes of the present thesis a series of experiments are planned to examine the role of AoA on monolingual Russian and bilingual Russian (L1) - English (L2) memory using the recently developed norms in Russian (Tsaparina et al, 2011). The theoretical explanation that AoA is a property of semantic memory was put to the test by examining AoA effects in bilingual Russian (L1) - English (L2) speakers in a series of free recall experiments as described in the following sections.

A Review of the Literature on AoA

The past 40 years has been marked by a rapid growth of studies focused on understanding the role of AoA on lexical and semantic processes as well as why this is the case. The first study on AoA was conducted by Rochford and Williams (1962) who found that the age at which children were able to name pictures correctly was correlated with a proportion of aphasic patients with who were also able to successfully name the same pictures. Carroll and White (1973) asked 20 adult participants to indicate an age when they believed they learned each word given using an 8-point rating scale (1 = age of 2-3 years to 8 = 14 years and older). The list of words was controlled for frequency effect. A significant difference was reported between words which were reported to be learnt earlier in comparison to those learnt later in life. On the contrary, there was no frequency effect. It was assumed that the age at which the word was learned has an influence on naming latency, and that word frequency rather has been incidentally associated with naming latency. Carroll and White (1973) concluded that '*memories for words, and possibly other items, are stored according to a chronological dimension rather than a frequency dimension*' (pp. 91-92). This led to a number of questions and debates around the subject of AoA, such as the relationship between AoA and frequency. Questions were also raised as to whether AoA reflected cumulative frequency. Various theoretical explanations were proposed to explain the AoA phenomenon including a proposition that earlier acquired words are more accessible for retrieval due to their organisation in deeper levels of cortical representation than words acquired later (see Johnston and Barry, 2006 for an overview). It was suggested that early acquired words are in a privileged position because they are represented bilaterally in the brain when late acquired words mostly represented in the cortical area responsible for speech. However this theoretical account have been confidently dismissed by a number of studies that failed to show any cortical asymmetry for early acquired or late acquired words (e.g. Boles, Rogers and Wymer, 1982; Ellis and Young, 1977).

Subsequent studies on AoA led to its acceptance as an influential variable that had to be taken in consideration in lexical processing (e.g. Gilhooly and Logie, 1980; Gilhooly and Logie, 1981; Gilhooly and Watson, 1981). Gilhooly and colleagues employed word recognition, word naming and memory tasks to explore AoA effects as a secondary variable. Morrison, Ellis and Quinlan (1992) replicated Carroll and White's (1973) study and confirmed that AoA but not word frequency affects picture naming. The same result was later reported for word naming (Morrison and Ellis, 1995). However it was not until Morrison and Ellis (1995) claimed the significance of AoA as an influential variable more so than frequency that led to the significant research in AoA.

Theoretical Accounts of AoA

An increased interest in the AoA effect led to the development of theoretical consideration that generated the following questions: What is the mechanism responsible for the emergence of the AoA effect? What is its locus in the lexico-semantic system? A variety of explanations were proposed some of which were had no empirical bases.

One of the early theoretical assumptions came from Brown and Watson (1987) who suggested that early acquired words are phonologically more complete in the mental lexicon than late acquired words. For late acquired words '*only minimal information is stored explicitly*' (p. 215) which can be explained by a limited storage capacity of memory. Hence, early acquired words can be accessed quicker when produced for naming. However the phonological completeness hypothesis faced difficulties explaining the mechanisms of existence of the AoA effect in lexical decision, semantic priming and face recognition tasks (see Johnston and Barry, 2006 for a review). A direct test of the phonological completeness hypothesis was conducted by Monaghan and Ellis (2002a) who assumed that if early acquired words were phonologically more complete than late acquired words then it would be more difficult to segment them. The authors tested three conditions of phonological segmentation in a deletion task, that is, participants were required to delete either a phoneme (e.g FROG= delete initial phoneme >ROG), onset (e.g. SPOON = delete onset >OON) or first syllable (e.g. HAVOC = delete first syllable >VOC) deletion. In contradiction to the phonological completeness hypothesis no reliable differences were found between early and late acquired words.

One theoretical explanation that came about as a consideration of the locus of the AoA effect was the semantic hypothesis (Brysbaert, Wijnendaele, and de Deyne, 2000). Language processing is a complicated process that requires involvement of both lexical and semantic representations. Most authors have explained AoA effects, particularly in word naming tasks, as having a lexical locus of origin not taking into account semantic representations of words and objects (see Johnston and Barry, 2006 for comprehensive review). The semantic hypothesis assumes that the magnitude of AoA effect will be higher in tasks that require access to semantic level of language processing. The main assumption is that semantic processing will be faster and more accurate for early acquired words because they are assumed to enter the representational system first and later acquired words were built up upon them, i.e. stronger semantic networks for earlier items. Hence, early acquired words influence the way late acquired words are represented. Brysbaert and colleagues (2000) have employed a variety of semantic task to test this hypothesis. For example, Brysbaert et al (2000) showed that the time needed to create a semantic associate was faster for early acquired words than for the words acquired later in life.

Despite the fact that semantic hypothesis has been a highly influential explanation of the AoA effect it nevertheless received criticisms. Izura and Ellis (2004) disputed against the semantic hypothesis presenting evidence from L2. According to their research, AoA effects in L2 depend on the age at which the word has been acquired in second language (L2) but not on the age at which corresponding L1 words was learnt. Therefore it means that semantic representation is shared between two languages and this fact challenges the semantic hypothesis. Noteworthy is that exploring how AoA affects free recall in bilinguals is one of the aims of the current thesis and will be further discussed in relation to Experiment 11.

It is important to note at this stage that accounts for AoA introduced above were based on mostly on behavioural data explained within localised representations in the mental lexicon. As introduced previously in Chapter 3, connectionist accounts of language processing were also developed to account for AoA effects. One such perspective is labelled as the cumulative frequency hypothesis *(*Zevin and Seidenberg, 2002) which critiqued word naming experiments which manipulated AoA from a methodological perspective. The main critique was that previous studies did not control cumulative frequency, that is, the total number of exposures to a word. According to this model learning is age-limited and that words learned earlier are encountered to more frequently through life. According to Zevin and Seidenberg (2004) '*AoA norms are a surrogate variable for the several aspects of words, including frequency trajectory as well as semantic and phonological factors, that determine when they are learned*' (p.32). In other words, early required words are processed faster and more accurately due to the fact that they encountered more often in life than late acquired words (Carroll and White, 1973; Lewis, Gerhand and Ellis, 2001). This means that AoA effects could be associated with a residence time of the word in memory and a number of times a participant encounters a word through their life (Johnston and Barry, 2006). Hence, cumulative frequency theory suggests that AoA effect and word frequency should be matched. Zevin and Seidenberg (2002) reanalysed word naming studies of Seidenberg and Waters (1989) and Spieler and Balota (1997) using post hoc multiple regression and cumulative frequency effect, but no AoA effect was found. However, it is important to note that the words Zevin and Seidenberg (2004) tested for frequency was presented in print only. Many words acquired during the "critical period" of language acquisition are acquired in spoken form. Other factors, such as the importance and necessity of the words (for example food names), emotional significance of the word (words related to social interaction, e.g. positive reinforcement like "mum" and "dad"), and phonological constraints (for example simple short words are learnt quicker than long and more complicated words) influence the process of language acquisition (Johnston and Barry, 2006). The relationship between AoA and frequency is undeniable but it has been demonstrated that AoA and frequency can yield orthogonal effects in studies that use carefully selected materials (e.g. Cortese and Khanna, 2007; Ghyselinck, Custers and Brysbaert, 2004; Menenti and Burani, 2007).

Morrison, Hirsh, Chappell and Ellis (2002) employed word and object naming tasks with younger (age 18 to 30) and older adults (60-90 years old) in order to test the claims of the cumulative frequency hypothesis. A predicted interaction, however, between AoA and participants' age was not found. A variety of studies (e.g. Gilhooly, 1984; Morrison et al., 2002; Lewis, Chadwick and Ellis, 2002) also failed to support the hypothesis. AoA was found to be a more significant predictor of naming latencies of early and late acquired words than "residence time". It was shown that AoA highly influence reaction times and cannot be explained by cumulative frequency account solely (Ellis and Lambon Ralph, 2000; Lewis, Chadwick and Ellis, 2002).

In brief, AoA has been empirically documented in a large number of studies (e.g. Belke, Brysbaert, Meyer and Ghyselinck, 2005; Cortese and Khanna, 2007) and compared to frequency effects (e.g. Gerhand and Barry, 1998a; Morrison and Ellis, 1995). Although the correlation between word frequency and AoA is high nevertheless AoA effect cannot be explained by one variable (cumulative frequency) only.

The arbitrary mapping hypothesis was proposed as an alternative account to AoA effects at about the same time as the semantic hypothesis (Ellis and Lambon Ralph, 2000). The authors explored the AoA effect using simulations from their connectionist model and assumed that AoA can affect multiple stages during word recognition. Early acquired items configures the network into the most advantageous to them, but late acquired items struggle to reach the same level of differentiation because the network '*becomes increasingly stable and rigid, showing a resultant decrease in its capacity to assimilate new patterns*' (p. 1108). Ellis and Lambon Ralph claimed that if the mapping between input and output items is inconsistent (in case of reading irregular words) or arbitrary (when learning new object names) AoA effect will be larger for late acquired items.

Further simulations by Monaghan and Ellis (2002b) found evidence for the arbitrary mapping hypothesis where AoA effect was found for inconsistent (irregular such as COLONEL, YACHT) items only. The prediction was made the AoA effect is mostly larger when the input and output items are arbitrary (inconsistent). The arbitrary mapping hypothesis postulates that the AoA activates the representational level between the input and output. It means that the strength of the AoA depends on how large the arbitrary mapping is. This principle is correct for tasks including naming pictures and their names, i.e. orthography to phonography representations are arbitrary.

The arbitrary mapping hypothesis provides a strong explanation for the AoA effects typically found in late acquired, low frequency irregular English words which are more likely to have arbitrary mapping between orthography to phonology. However, it does not predict an AoA effect where mappings between orthography and phonology are *non-arbitrary,* i.e. direct. The claims of this hypothesis were put to the test in a word naming task in Turkish which has a highly transparent orthography in which the mappings between orthography and phonology are very predictable. Although previous reports of significant AoA effects emerged from other relatively transparent orthographies such as Dutch (Brysbaert et al, 2000) Turkish presents a much more transparent orthography in order to put to the claims of the arbitrary mapping versus semantic hypothesis to the test. Raman (2006) reported a significant main effect for AoA in a naming task which was taken as evidence that AoA effects were not specific to arbitrary mappings but a universal effect and a property of the semantic system.

The arbitrary mapping hypothesis is of interest to bilingual research especially when the AoA effect is explored between languages of different orthographic transparency. However, one must note that the model is a computational one that is based on simulations. The AoA studies in monolingual research across languages will be discussed further in this Chapter.

AoA in experimental tasks

As reported above, AoA effects have been investigated in a variety of lexical and semantic processing tasks. This effect has been reported in a number of tasks that require lexical retrieval, for example word naming tasks. Moreover, the AoA effect is found in tasks that do not require lexical retrieval, such as object recognition tasks, discussed below. Overall, AoA effects are found in a variety of domains including written naming, word pronunciation tasks, face recognition, recognition memory and free recall tasks (see Johnston and Barry, 2006 for reviews).

As introduced in Chapter 4, lexical decision is a commonly used experimental task and can be applied to different modalities, such as in visual and auditory domains. A few studies employing lexical decision tasks have shown that early acquired words are recognised quicker and more efficient than words acquired later when they have to be distinguished from nonwords (Morrison and Ellis, 1995; Nagy, Anderson, Schommer, Scott, and Stallman, 1989). In English, the AoA effect has been found in lexical decision tasks showing that it primarily contributes to the retrieval of lexical phonology (Gerhand and Barry, 1999b). In addition, AoA has been also found in experiments focused on object recognition and/or object naming. Ellis and colleagues (2006) found that early acquired objects are recognised and named faster that objects acquired later in life (Urooj, 2014). AoA effects on object naming has been shown in different monolingual object naming experiments including those in English (Barry, Hirsh, Johnston and Williams, 2001; Ellis and Morrison, 1998; Snodgrass and Yuditsky, 1996); Spanish (Cuetos, Ellis and Alvarez, 1999) and French (Bonin, Chalard, Meot and Fayol, 2002).

Picture naming is reported to be affected by a number of factors one of which is AoA (e.g. Barry, Morrison and Ellis, 1997; Cuetos, Alvarez and Ellis, 1999; Snodgrass and Vanderwart, 1980). Since the publication of the Snodgrass and Vanderwart (1980) picture norms reporting AoA ratings a large body of research has used them in object naming and recognition tasks in many languages of the world in Chinese (Weekes, Shu, Hao, Liu, and Tan, 2007); English (e.g. Barry et al., 1997); French (Alario and Ferrand, 1999; Bonin, Peereman, Malardier, Méot, and Chalard, 2003); Greek (Dimitropoulou, Duñabeitia, Blitsas, and Carreiras, 2009); Icelandic (Pind, Jónsdóttir, Tryggvadóttir, and Jónsson, 2000); Italian (Nisi, Longoni, and Snodgrass, 2000); Japanese (Nishimoto, Miyawaki, Ueda, Une, and Takahashi, 2005); Persian (Bakhtiar, Nilipour, and Weekes, 2013); Russian (Tsaparina, Bonin and Méot, 2011); Spanish (Sanfeliù and Fernandez, 1996; Cuetos, Ellis and Alvarez, 1999); and Turkish (Raman, 2011; Raman et al, 2014).

Several experiments were conducted in order to explain the AoA effect that presents in word and picture naming tasks (Gerhand and Barry, 1998, 1999a; Monaghan and Ellis, 2002a, 2002b; Morrison and Ellis, 1995, 2000). However, most of the studies that explore AoA in naming tasks used either picture or words stimuli but not both. Several studies that used both pictures and their names, i.e. words, for naming report different results and suggest that different mechanisms are responsible for their processing in Italian (Bates, Burani, Barca and D'amico, 2001) and in Turkish (Raman, 2011). As reported in Chapter 3, words are processed the lexico-semantic system while pictures are assumed to be processed by the semantic system.

AoA has been investigated in a number of languages other than English which showed that the AoA effect is a universal phenomenon found in a range of orthographies and is assumed to be an 'inherent *property of the functional architecture of lexical processing*' (Raman, 2006; Raman 2011). AoA has been observed in alphabetical languages with different levels of orthographic transparency. This is contrary to the predictions of the arbitrary mapping hypothesis which did not predict a reliable AoA effect in transparent writing systems (Lambon Ralph and Ellis, 2000). In transparent Dutch, AoA effects were reported and the results of the study showed that AoA is an important variable in the processing of visually presented words (Ghyselinck, Custers and Brysbaert, 2004). In Italian, AoA was tested in word naming tasks; however it did not show any effect on the speed of words' pronunciation (Barca, Burani, and Arduino, 2002). One of the criticisms of the study was that the stress assignment was not controlled for in the experiment and that AoA effect was reported for word naming under regular stress assignment (Wilson, Burani and Ellis, 2012).

One important note is that the review of AoA literature thus far has been limited to mostly monolingual experiments with the exception of Izura and Ellis (2004). This is also true in case of experiments that examined the role of AoA on free recall. To summarise, in English Morris (1981) reported that late acquired words were better recalled than early acquired words while Coltheart and Winograd (1986) and Gilhooly and Gilhooly (1979) found no effects of AoA on recall. Dewhurst, Hitch and Barry (1998) found reliable AoA and frequency effects in mixed lists only while late acquired, low frequency words were better recalled compared to early acquired, high frequency words.

One of the few studies exploring AoA effect in bilingual population was conducted by Izura and Ellis (2002) who employed picture naming and lexical decision tasks to study AoA effects in both L1 (Spanish) and L2 (English). Spanish (L1) - English (L2) bilinguals were asked to rate the age at which they thought they first learnt Spanish words. The result of the experiment replicated AoA rating collected from monolingual Spanish speakers. The bilinguals were also asked to rate at what age they learnt English words (L2). The results showed that AoA has an effect on picture naming and lexical decision times in Spanish (L1) as well as on bilinguals' picture naming and lexical decision times in English (L2). A multiple regression analysis demonstrated that the AoA L2 effect was independent from the AoA L1 effect and native language did not contribute to the ratings of L2 AoA. To confirm this result Izura and Ellis (2002) compared lexical decision times separately for early acquired words learned in Spanish and for their English equivalents acquired later in life (e.g. *zapatillas (L1)* – *slipers (L2)*). The analysis showed that when participants responded to the words in Spanish (L1) they responded quicker to early acquired Spanish words than to the words acquired later in English (L2). The opposite tendency was registered when participants were asked to respond to the words in English: even if overall their time reaction was slower, but they responded faster to the English (L2) early acquired words than to the late acquired words in Spanish (L1). The AoA effects were confirmed to be language specific showing that order of L2 acquisition is a crucial factor. In contrast to monolingual speakers bilinguals can start L2 acquisition after the "critical period". Izura and Ellis (2002) argue that significant neurological changes happen after this period which can hinder L2 acquisition but a number of bilingual speakers start to acquire L2 much later than the L1, that is, after the “critical period”. Studies of bilingual language processing must therefore control for the age of L2 acquisition and/or proficiency where possible.

Returning to the current study, one important note is that Russian children start to learn English approximately between 8 to 10 years of age and continue to learn English as L2 until graduation from high school at the age of 17. However, with higher demands on bilingualism and fluency in English a portion of high school graduates continue to study English.

In the current thesis a series of experiments will examine the role of AoA on monolingual Russian and bilingual Russian (L1) - English (L2) memory using the recently developed norms in Russian (Tsaparina et al, 2011). The theoretical explanation that AoA is a property of semantic memory will be put to the test by examining AoA effects in bilingual Russian (L1) - English (L2) speakers in a series of free recall experiments.

In summary, this Chapter has reviewed research on AoA together with theoretical accounts that provide an explanation for its emergence in a variety of lexical tasks. Three main accounts are offered, namely, the cumulative frequency hypothesis whereby frequency and AoA both influence the number of encounters with a word, which influences processing speed (Zevin and Seidenberg, 2002); the semantic hypothesis which supposes that early-acquired words are processed faster because they are more central in the semantic network (Brysbaert et al, 2000), and the arbitrary mapping hypothesis which claim that early acquired words are faster because they are acquired when a network has maximum plasticity (Lambon Ralph and Ellis, 2000).

AoA and Memory

As has been discussed above the AoA effect is a widely observed phenomenon in lexical and semantic tasks. However, the role of AoA in memory tasks is not that obvious. As reported under Chapter 4, free recall task is an experimental method for exploring the organisation of episodic memory. Under the free recall task, participants are typically presented with a list of items (words, pictures) to be learnt and after a distractor task, asked to recall as many items as possible from the list.

The free recall task has been instrumental in investigating the influence of AoA especially whether it is involved in the organisation of episodic memory. One of the pioneering studies in this respect was conducted by Morris (1981) who used a list of early and late words mixed together. Morris (1981) reported that late acquired words were better recalled than early acquired words. This finding was counterintuitive as early acquired items are expected to have stronger representations in memory. The study was replicated by Coltheart and Winograd (1986) in a pure list condition who reported no effect of AoA (see Chapter 4 for a review of list or context effects in experimental tasks). Dewhurst, Hitch and Barry (1998) combined the experimental methods used by Morris (1981) and Coltheart and Winograd (1986) in an experiment employing both a mixed list and pure list design. Dewhurst et al (1998) reported a significant main effect for AoA in in the mixed list only. Participants managed to recall more late acquired than early acquired words; and more words of low than high frequency words. The results were taken to indicate that AoA effect was a modifiable effect prone to context effects (i.e. list effects) and that late acquired words appeared to influence the encoding hence the retrieval of episodic memory differently (perhaps with stronger, more permanent semantic representations) than early acquired words. In the pure list condition, Dewhurst et al (1998) reported only a significant frequency effect which was reversed, that is, participants were better at recalling high frequency words compared to low frequency words. AoA effect was nonsignificant in the pure list condition and no interaction between the two variables. Dewhurst et al concluded that '*Findings were attributed to the more distinctive encoding of low-frequency and late-acquired words*' (p284).

It is important to note that evidence of the AoA effects and frequency influence on the free recall has been limited to English only (Morris, 1981; Coltheart and Winograd, 1986; Dewhurst et al, 1998). However, more recently, Raman et al (under review) have examined the role of AoA on free recall of pictures and their names (words) in Turkish and have reported contradictory findings to word recall in English. Raman et al are the first to include pictures in a free recall task in order to examine AoA effects. It must be noted that the words were the picture names obtained from AoA norms.

Previous research on Turkish (Raman, 2006; 2011; Raman et al 2014) found a significant and reliable effect for AoA in naming. This finding was contrary to the predictions of the arbitrary mapping hypothesis (Lambon Ralph and Ellis, 2002) which proposed that AoA effects in English came about because of 'arbitrary' mappings between orthography and phonology. Raman (2006) tested this hypothesis in a naming task using early and late acquired words in Turkish which possesses a highly predictable orthography in which orthography to phonology mappings are *not* arbitrary. A significant AoA effect was taken to indicate that AoA was a '*global'* effect and *'an inherent property of the functional architecture of lexical processing, thus a universal factor similar to word frequency effect*' (Raman, 2006, p1049). In addition, this effect was replicated in picture and word naming with adult dyslexic university students (Raman, 2011) further confirming the earlier conclusion. In a further study, the role of AoA was investigated in a partial replication of Dewhurst et al.'s (1998) study with the addition of pictures chosen from AoA norms in

Turkish. The items were either early or late acquired pictures or their names (words). Frequency of the items was also controlled. The study showed that high frequency early words were better recalled than low frequency early words. These results provided an understanding of AoA influence on the very transparent Turkish orthography. In the context of the current study the AoA effects found in opaque English language (for example Dewhurst et al., 1998) and in very transparent Turkish language (Raman, Raman, Ikier, Kilecioglu, Uzun and Zeyveli, 2015; under review) are of great interest. This is because any model that account for AoA effects should be able to do so universally across all types of writing systems.

In a partial replication of Raman et al (2015; under review), pictures will also be used together with their names (words) to explore if AoA affects free recall of words and pictures to the same extent. It is well documented in the literature that information is more likely to be recalled when it is presented in pictures compared to in words (Paivio, 1971; Rajaram, 1996). This view is based on the functionalist account of human memory (Nairne, 2010) which considers the fact that the processing pictures precede the processing of language (e.g., words) in the evolution of human memory (Paivio, 2007).

Experiment 10: The role of AoA on monolingual Russian speakers in a free recall task

The aim of the experiment 10 was to investigate the AoA effect on words and picture free recall in Russian (L1) monolinguals. This is because there are no previous reports on AoA in Russian bar two recent normative studies (Akinina et al, 2015; Tsaparina et al, 2011). It is therefore of importance to establish that AoA effects in free recall exist in monolingual Russian speakers before turning our attention to bilingual Russian (L1) –English (L2) speakers.

One further aim of Experiment 10 was to ask participants to rate the age when they thought they learnt the items after they competed the experimental task. The data were subsequently used to validate the norms reported in the literature and to ensure their reliability.

Method

Design

A factorial design using a 2 (AoA: Early, Late) x 2 (Stimulus type: picture, picture name/word) x 2 (List type: pure, mixed) where AoA was a within subject variable and Stimulus type and List type were the between subjects conditions. The raw scores on correctly recalled items was the dependent measure.

Participants

A total of 42 (31 women and 11 men in age between 17 and 22, mean age 20.4) monolingual Russian speakers who were university students were recruited from St. Petersburg State Paediatric Medical Academy in St. Petersburg, Russia. All the participants were native monolingual Russian (L1) speakers. Participants were allocated to experimental conditions as follows: 11 in pure word list and 10 in mixed word list; 11 in pure picture list and 10 in mixed picture list.

Materials

The experimental stimuli were selected from the Russian normative data recently developed by Tsaparina et al (2011) based on the colour picture norms (Rossion and Pourtois, 2004) of the original Snodgrass and Vanderwart black and white line drawings (1980). The Russian norms were standardised for age of acquisition and subjective word frequency along with name agreement, image agreement, conceptual familiarity and imageability (Tsaparina et al, 2011). Pictures and their names (words) were selected to be used in the picture and word recall respectively. In addition an attempt was made to match early and late items also on frequency.

Early and Late AoA items were carefully selected based on the following analyses: In total 50 pictures (and picture names), half of which were early acquired and the other half late acquired items were used. The early acquired picture mean score was 1.5 (SD=0.16); the late acquired mean score was 2.6 (SD=0.64). This means that early items were acquired by approximately 5.5 years of age, and late items were acquired approximately at the age of 9. A comparison of early acquired with late acquired words showed a significant difference, $t(24)=11.23$ $p<0.0001$, therefore upholding their status.

Procedure

The study commenced after ethical approved was granted by the Psychology Ethics Committee at Middlesex University and permission was given by the St. Petersburg State Paediatric Medical University. Participants were tested one by one in a single session after giving informed consent in a quiet room located at the Department of Clinical Psychology, at St. Petersburg State Paediatric Medical University. Participants were presented with a list of pictures or picture names (words) under pure or mixed conditions. The stimuli were presented using a PowerPoint presentation with each picture or picture name (word) shown for 2000ms followed by a 1000ms interval before the next stimulus was presented. In the first or learning phase of the experiment, participants were randomly allocated to either a mixed list or a pure list condition. Under the mixed condition early and late acquired items were randomly mixed. In the pure list condition two blocks were created, one for early and the other for late acquired items. The presentation of the two blocks was subsequently counterbalanced in order to avoid order effects. Once participants saw all the items, they were given a simple mental numerical exercise to count backwards from 999 in 3s for three minutes. This was to avoid a recency effect, that is, the memorisation of the last items on the list. Finally, in the recall stage of the experiment participants were provided with a blank sheet of paper and asked to recall as many items as possible.

After the completion of the experimental task, participants were given a rating sheet with all the experimental stimuli and were asked to estimate the age at which they had acquired each of the items. The AoA ratings were based on Tsaparina et al (2011) norms.

Results

The data analyses on the number of correctly recalled items were conducted using descriptive and inferential statistics by way of a 2 (AoA: Early, Late) x 2 (Stimulus type: Picture, picture name/word) x 2 (List type: pure, mixed) mixed ANOVA.

Table 12: Experiment 10: Mean (in number of recalled stimuli), their corresponding standard deviations (SD) and number of participants for free-recall task in monolingual Russian speakers under pure and mixed list types

	List type					
Condition	Pure			Mixed		
	Mean	SD	N	Mean	SD	N
Early words	8.6	1.63	11	8.6	1.58	10
Late words	7.5	1.63		6.6	1.90	
Early pictures	10.8	2.4	11	10.6	1.43	10
Late pictures	7	1.9		8.4	2.72	

The results show a robust main effect for AoA effect in free recall irrespective of list type for words [$F(1,19) = 9.44$ $p<0.006$), $\eta^2 = 0.29$] and for pictures [$F(1,19) = 46.9$ $p<0.0001$,

$\eta^2 = 0.69$] None of the interactions reached statistical significance. It is interesting to see that the findings are contrary to what has been reported in the literature for monolingual English speakers (Dewhurst et al, 1998) but in line with findings reported for Turkish (Raman et al, 2015; under review). To the best knowledge of the researcher, this is the first report of AoA effect in Russian in a free recall task for words and pictures. The implications of the findings will be discussed fully under general discussion in view of current theoretical perspectives of AoA.

Experiment 11: The role of AoA effect in bilingual Russian (L1)- English (L2) speakers in a free recall task

The aim of Experiment 11 was to replicate Experiment 10 by employing bilingual Russian (L1) – English (L2) speakers in order to address the issue of whether AoA is involved in the organisation of memory in L1 and L2. The method was almost identical to Experiment 10 with the main difference being the addition of picture name (word) stimuli in English (L2).

Design

Experiment 11 employed a factorial design with a 2 (AoA: Early, Late) x 2 (Language: Russian or English) x 2 (Stimulus type: picture, picture name/word) x 2 (List type: pure, mixed) conditions. The AoA was within subjects and Stimulus type, List type and Language were between subjects conditions. The participants were presented with either a list of picture names (words) in Russian (L1) or in English (L2) separately. The number of correctly recalled items was used as the dependent variable.

Participants

The participants were bilingual Russian (L1) – English (L2) university students (N=40; 28 females and 12 males, mean age = 19.5) recruited from St. Petersburg State Paediatric

Medical Academy in St. Petersburg, Russia participated in the experiment. None of the participants studied English before the age of 8 years and all of the participants were proficient L2 speakers who continued to learn English at least until the age of 17 or later. The language proficiency was measured using the Schonell Reading Test (1971).

The allocation of 21 participants to conditions in Russian (L1) is as follows: 5 in pure word list and 6 in mixed word list; 5 in pure picture list and 5 in mixed picture list. The allocation of 19 participants to conditions in English (L2) is as follows: 5 in pure word list and 4 in mixed word list; 6 in pure picture list and 4 in mixed picture list.

Materials

The pictures and picture names (words) used in Russian were the same as in Experiment 10. The items' corresponding English translations were matched to the AoA English norms using Snodgrass and Vanderwart (1980) and the colour version picture norms (Rossion and Pourtois, 2004). Rating data collected for English (L2) at the end of the experiment were used in correlational analyses reported below to ensure that items were reliably corresponded with early and late AoA.

Procedure

The study commenced after ethical approved was granted by the Psychology Ethics Committee at Middlesex University and permission was given by the St. Petersburg State Paediatric Medical University. Participants were tested one by one in a single session after giving informed consent in a quiet room located at the Department of Clinical Psychology, at St. Petersburg State Paediatric Medical University.

The procedure was the same as in Experiment 10. Stimuli were again pictures and picture names (words) presented either in a pure or mixed block design for free recall. Half of the participants were presented with the experimental task in Russian (L1) and other half in English (L2).

As in Experiment 10, after the experimental task was completed each participant was asked to rate the age at which they acquired a particular picture either in Russian (L1) or in English (L2). Allocation to AoA rating was based on which experimental condition the participants were allocated. Therefore participants who completed the free recall task in Russian (L1) rated AoA in Russian and those who completed the free recall task in English (L2) rated AoA in English. The collection of AoA ratings in L1 and L2 were used to further evaluate the reliability and the validity of the Russian normative data on AoA (Tsaparina et al, 2011).

Results

The data were analysed using descriptive statistics and a 2 (AoA: Early, Late) x 2 (Stimulus language: Russian – English) x 2 (Stimulus type: Picture, picture name/word) x 2 (List type: pure, mixed) mixed ANOVA.

As can be seen in Table 13, recall of early words and pictures were superior to late words and late pictures irrespective of list type. The findings are contrary to those reported in English (Dewhurst et al, 1998) for monolinguals and line with the findings reported in Turkish (Raman et al, 2015; under review). The ANOVA results showed a robust main effect for AoA effect in free recall irrespective of list type for words [F (1,8) = 30.56 p<0.0001), η^2 = 0.76] and for pictures [F (1,8) = 28.6 p<0.001, η^2 = 0.77). None of the interactions reached statistical significance. To the best knowledge of the researcher, this is the first report of AoA effect in Russian in a free recall task for words and pictures.

Table 13: Experiment 11: Mean (in number of recalled stimuli) and their corresponding standard deviations (SD) and number of participants for free-recall task in Russian (L1)

	List type					
Condition	Pure			Mixed		
	Mean	SD	N	Mean	SD	N
Early words in Russian	9.8	0.84		10.5	1.52	
Late words in Russian	6.2	2.2	5	5.5	2.66	6
Early pictures	11.6	1.52		10.2	0.84	
Late pictures	8.4	2.41	5	6.6	1.52	5

The descriptive statistics in Experiment 11 reported in Tables 14 were split into recall scores in Russian (L1) and English (L2) for a simpler presentation. As can be seen in both tables, bilingual Russian (L2) – English (L2) participants showed a similar pattern of results to monolingual Russian participants in Experiment 10. That is, early acquired words and pictures were better recalled than late acquired items overall.

Table 14: Experiment 11: Mean (in number of recalled stimuli), their corresponding standard deviations (SD) and number of participants for free-recall task in English (L2)

	List type					
Condition	Pure			Mixed		
	Mean	SD	N	Mean	SD	N
Early words in English	7.6	1.14		8	2.2	
Late words in English	2.8	1.48	5	5.2	1.26	4
Early pictures	5.5	1.38		5	1.41	
Late pictures	3.2	0.98	6	4.5	1.49	4

Interim Discussion

The aim of Experiments 10 and 11 was to investigate if AoA influenced free recall in monolingual and in Russian (L1) – English (L2) bilingual speakers under mixed and pure conditions using pictures and picture names (words).

Data from Experiment 11 were formally analysed using a 2x2x2x2 mixed ANOVA and for the word data, the results showed a reliable main effect for language [F (1,16) =43.87 p<0.0001 η^2 =0.73] but not for AoA [F<1] and a significant interaction between-language and AoA [F(1,16) =12.25 p<0.005 η^2 =0.43]. Post hoc tests showed that while early AoA words were significantly better recalled in Russian (L1) than in English (L2) this was not the case for late AoA words. For pictures there was also a significant main effect for language [F(1,16)=72.68 p<0.0001 η^2 =0.82] but this time also for AoA [F (1,16) =10.47 p<0.001 h2=0.40]; none of the interactions reached statistical significance.

It is important to note however that although list type did not yield significant differences, under English (L2) conditions participants overall performed better in recalling words and pictures under the mixed list compared to the pure list condition especially for late items (mean recall of late words in pure list is 2.8 versus 5.2 in mixed list, and late pictures in pure list is 3.2 versus 4.5 in mixed list). Noteworthy is that when participants were required to recall items in Russian (L1) contrary results were found overall with only early items being better recalled under the mixed compared to the pure list condition (mean early word recall 9.8 vs 10.5 respectively).

One of the additional goals of Experiments 10 and 11 were to explore whether the picture AoA ratings from the current study were in line with those reported in the literature. The rationale for only using pictures for AoA ratings was based on the universal aspect of picture processing which is assumed to be language independent (Raman et al 2014). This also ensured that rating in Russian (L1) and English (L2) had comparable results between monolingual and bilingual participants.

For monolingual participants in Experiment 10, the rating data for 50 items were entered into a correlational analyses using Pearson's which found a significant relationship between the current ratings and Tsaparina et al (2011) AoA norms [r(50)=0.63 p<0.0001].

Moreover, a significant correlation was also found between the current ratings and those reported recently in a large normative study for 25 languages (Lumiewska et al, 2016) for 29 items, $r(29)=0.74$ $p<0.0001$. For bilingual participants in Experiment 11, significant correlations were found in English (L2) AoA picture ratings between the current study and the English norms reported by Tsaparina et al (2011) [$r(50)=0.51$ $p<0.0001$]; the original Snodgrass and Vanderwart (1980) [$r(47)=0.55$ $p<0.0001$] as well as Cortese and Khanna (2008) [$r(41)=0.51$ $p<0.005$]. Therefore, the reliability of the items used in Experiments 10 and 11 can be confidently established. This is an important aspect of AoA experiments as AoA norms are often criticised for being based on subjective ratings (see Morrison and Ellis, 1995 for an overview).

Overall, these findings are in line with the experimental hypotheses which predicted that because L2 words enter into the bilinguals' lexicon later than L1, one cannot expect a comparable or same magnitude of AoA effect under these circumstances. Evidence from pictures show a robust AoA effect since picture processing is assumed to be language independent. These results are in line with the predictions of the semantic hypothesis (Brysbaert et al, 2000) and are taken to indicate the role of AoA in the ongoing construction of bilingual memory. It appears that even though there may not be L1 specific effects on free recall in L2, L2 speakers differ from monolinguals in terms of the semantic organization of their language processing system.

8. Chapter 8: General Discussion

Preface

The present thesis set out to examine lexico-semantic processing in bilingual Russian (L1)-English (L2) speakers. Of particular interest were the two key questions raised within the bilingual literature context and related to the current research programme:

i) how the two languages of a bilingual are organised or stored, that is, whether each language is stored in one or more locations in bilingual memory and

ii) how the two languages are processed, i.e. what mental capacities are required to process each language

Given the general lack of literature on lexico-semantic processes in Russian speakers, the attention first turned to monolingual Russian speakers in order to gather evidence and to establish a theoretical framework of lexico-semantic processes in Russian.

Searching for lexico-semantic processes and the role of AoA on free recall in monolingual Russian speakers

The present study was initially motivated to address key issues in relation to research by examining the underpinning lexico-semantic processes bilingual Russian (L1)-English (L2) speakers. This interest was primarily based on the unique properties of the Russian orthography which is based both Cyrillic and Roman alphabets, creating a shared orthographic medium for the bilingual Russian (L1)-English (L2) speakers given the English orthography is also based on Roman. The objective of the research programme was to discover the extent to which this shared orthographic medium would affect lexico-semantic processing including memory. A review of the bilingual literature showed that evidence from different orthography pairs was inconclusive but more importantly, as reported in Chapter 5, there was little evidence reported on lexico-semantic processes in monolingual Russian speakers. As introduced previously under the dual-route model of visual word recognition (Coltheart, 1978; Rastle and Coltheart, 1999) in Chapter 3, lexico-semantic processes refer to qualitatively distinct cognitive processes in visual word recognition research. That is, the way in which we are able to pronounce a written word, i.e. generate phonology (sound) from orthography (print) can either be possible by a) addressing previously stored phonological (sound), orthographic (spelling, print) and semantic (meaning) representations in long term memory, namely, the mental lexicon or b) by assembling phonology from orthography by employing the alphabetic rules or principles to letter strings. The process (a) of addressing previously stored representations for words was labelled as the lexical route and the process (b) of assembling words' pronunciation based on rules was labelled as the nonlexical route. It is important to note that the dual-route model (Coltheart, 1978) was originally proposed to address a key issue in English orthography, namely the directness with which one can accurately generate or predict phonology from orthography. Although some words in English can be accurately pronounced by directly assembling sound from print (e.g. SAVE, GAVE, WAVE) the same process would fail for others (e.g. HAVE, COLONEL, YACHT), i.e. for regular versus irregular words, respectively. Although, the unpredictable or irregular nature of English orthography was well documented (Venezky, 1970), the dual route model was nevertheless the first to theoretically account for the impact of this diversity on processes involved in visual word recognition. According to the model, regular English words (as well as regularly transcribed new words/nonwords) can be read via the nonlexical route whereas regular and irregular words known to the reader can be read via the lexical route. Furthermore, each of the routes is assumed to be sensitive to different psycholinguistic variables. For instance, the lexical route is assumed to be sensitive to words' frequency leading to the faster processing of common versus uncommon words, i.e. the word frequency effect, whereas the nonlexical route is assumed to be sensitive to the physical characteristic of words such as length (e.g. Weekes, 1997; see Besner, 1999 for a review).

Henderson (1982) observed that soon after the dual route model was published, there was a move to '*colonise'* the world's orthographies based on the directness with which one could attain phonology from orthography, leading to the supposition of orthographic transparency. In this respect, orthographies with more direct or predictable links between orthography to phonology such as Italian and Spanish were categorised as transparent while those with less direct or unpredictable links such as English and Hebrew were categorised as opaque. Furthermore, suppositions were made with regards to the operation of each of the routes based on orthographic transparency leading to the proposal of the orthographic depth hypothesis (Frost et al, 1987). It was claimed that reading in transparent writing systems primarily would utilise the nonlexical route and in opaque writing systems the lexical route. Baluch and Besner (1991) tested the claims of the orthographic depth hypothesis and found no empirical evidence to support it. More importantly, Baluch and Besner (1991) proposed that the two routes of the dual route model were in operation for all types of orthographies irrespective of transparency and that the lexical route was the more dominant one of the two. This led to the proposal of the universal hypothesis in visual word recognition (Baluch and Besner, 1991). Research from a wide range of different orthographies, mostly alphabetic writing systems have provided unprecedented evidence for the existence of different processes as described by the dual route model and for the universal hypothesis. One such study was conducted in Turkish which has one of the most transparent writings systems reported to date (Raman et al, 1996). Contrary to the prediction of the orthographic depth hypothesis a reliable word frequency effect was found and further supported the involvement of the lexical route as predicted by the universal hypothesis. For the purpose of this thesis, a revised version of the dual route model (Besner, 1999) introduced in Chapter 3 will be used because it makes explicit reference to a semantic lexicon and hence to a lexico-semantic route which can be employed to generate pronunciation in visual word recognition. The addition of this route enables an account when the reader has to generate appropriate pronunciation for words with identical orthographic representation but different pronunciations achieved via context; for example, reading (verb) versus Reading (city in England). It is important to note that the dual route model of visual word recognition is directed to understanding the processes in monolingual visual word recognition and therefore more relevant to Experiment 1 in the current thesis.

In summary, attention was diverted to establishing an understanding of the lexico-semantic processes involved in monolingual Russian speakers in Experiment 1. This was important on two accounts: i) to explore whether current reports on semantic and lexical processing from other orthographies could be extended to Russian and ii) to create an empirical and theoretical platform from which bilingual Russian (L1)-English (L2) research could proceed. Arguably, a universal model of understanding lexico-semantic processes across all the languages of the world is the overarching aspiration of theoretical models in this field. In this respect, as discussed in Chapters 3 and 4 semantic priming has been reported to be one of the most influential experimental paradigms that is linked to exploring semantic processes by way of semantic networks and semantic activation (Collins and Quillian, 1969; Collins and Loftus, 1975). Semantic priming refers to the phenomenon that the naming or recognition of a target word (DOCTOR) is faster when the preceding prime is related (NURSE) in meaning than when it is unrelated (BUTTER). In a seminal paper Meyer and Schvaneveldt (1971) reported one of the most significant empirical findings in the history of word recognition research showing that in monolinguals word recognition happens faster if a word to be recognised immediately follows a word that is related in meaning. A review of the literature in Chapter 4 suggests that activation of semantic networks in response to a prime generates a lasting effect which can influence the processing of the target and that this is a universal finding irrespective of type of orthography. In addition, semantic networks and semantic activation form the basis of semantic lexicon in the dual route model of visual word recognition (Besner, 1999). In this respect, data from monolingual Russian speakers will be informative for both the dual route model of visual word recognition as well as semantic networks.

As discussed in Chapter 4, for the purpose of semantic priming experiments reported in this thesis, the general methodology adopted is the use of naming tasks to record RTs and accuracy where participants are required to name targets which follow visible primes. The prime-target relationships were based on associations. As critically evaluated in Chapter 4, two different types of mechanisms assumed to be involved in semantic priming, that is, automatic or attentional, have been linked to the processes involved in masked (prime is hidden and presented for a very short time) and visible semantic priming (prime is clearly visible for up to 500ms) tasks respectively. Briefly, while masked priming has been reported to be an effective technique for examination of automatic processing involved in visual word recognition (for an overview, see Grainger, 2008), visible priming is a method used to examine attentional processes. Given that visible semantic priming is assumed to reflect processes involved in normal reading better than masked priming its selection is justified given the aims of the current thesis.

As discussed in Chapter 4, the rationale of employing naming tasks in semantic priming over other tasks was motivated by predictions of the theoretical models. A reliable priming effect together with RTs and accuracy scores will be useful to establish an understanding of the lexico-semantic processes in visual word recognition under related versus unrelated experimental conditions. The findings collectively will help build a theoretical framework, discussed below, for monolingual and bilingual processing.

The aim of Experiment 1 was to explore the extent to which monolingual Russian speakers target word naming would be influenced by activation of related versus unrelated primes. Results showed a significant semantic priming effect of 25ms where participants were faster to respond to target words under the related condition (515ms) compared to the unrelated condition (540ms). This finding is in line with the predictions of the semantic activation hypothesis and is reported in naming Russian words for the first time.

One other experiment was designed to examine monolingual Russian language processing, this time to examine the role of AoA on free recall. AoA effect can be defined as the difference in processing time between early acquired words and objects compared to late acquired words and objects where early items have an advantage over late items (see Johnston and Barry, 2006 for a review). The rationale for choosing AoA as the next line of query in this thesis in relation to Russian language processing is because of its close association with semantic networks and activation (Collins and Quillian, 1969; Collins and Loftus, 1975). As discussed in Chapter 7, AoA is an interesting and a contemporary psycholinguistic variable which came first to the attention of visual word recognition researchers over half a century ago (Rochford and Williams, 1962). It is also an equally controversial variable as it has also been argued to be simply cumulative frequency whereby number of encounters with a word directly influences processing speed (Zevin and

Seidenberg, 2002). One other consideration in this respect is its close link to the chronological organisation in the mental lexicon. Lambon Ralph and Ellis (2000) claim in their arbitrary mapping hypothesis that early acquired words are faster because they are acquired when a network has maximum plasticity. As discussed in Chapter 7, both these accounts are based on simulations and not on behavioural evidence. Semantic hypothesis supposes that early-acquired words are processed faster because they are more central in the semantic network (Brysbaert et al, 2000). This position is closely linked to the aims of the thesis, i.e. investigation of lexico-semantic processing in Russian, and its claims will be tested in the two AoA experiments reported here.

One important aspect of lexico-semantic processing is the activation of long term memory in the processing of words. As discussed in Chapter 4, free recall task is of particular interest here because it is assumed to be a component of episodic memory and therefore useful to further examine whether AoA has any influence in memory organisation in monolingual Russian and bilingual Russian (L1)-English (L2) speakers. This query is topical and in line with current trends on the AoA literature that poses the two key questions: What is the mechanism responsible for the emergence of the AoA effect? What is its locus in the lexico-semantic system?

Pervious research on English found AoA effects in lexical decision tasks showing that it primarily contributes to the retrieval of lexical phonology (Gerhand and Barry, 1999b). In addition, AoA has been also found in tasks focused on object recognition and/or object naming. Ellis and colleagues (2006) found that early acquired objects are recognised and named faster that objects acquired later in life (Urooj, 2014). AoA effects on object naming has been shown in different monolingual object naming experiments including those in English (Barry, Hirsh, Johnston and Williams, 2001; Ellis and Morrison, 1998; Snodgrass and

Yuditsky, 1996); Spanish (Cuetos, Ellis and Alvarez, 1999) and French (Bonin, Chalard, Meot and Fayol, 2002). In addition, picture naming is reported to be affected by a number of factors one of which is AoA (e.g. Barry, Morrison & Ellis, 1997; Cuetos, Alvarez & Ellis, 1999). AoA effects has been reported in many languages such as Spanish (Sanfeliù & Fernandez, 1996; Cuetos, Ellis & Alvarez, 1999); French (Alario & Ferrand, 1999; Bonin, Peereman, Malardier, Méot, & Chalard, 2003); Icelandic (Pind, Jónsdóttir, Tryggvadóttir, & Jónsson, 2000); Italian (Nisi, Longoni, & Snodgrass, 2000); Japanese (Nishimoto, Miyawaki, Ueda, Une, & Takahashi, 2005); Chinese (Weekes, Shu, Hao, Liu, & Tan, 2007); Greek (Dimitropoulou, Duñabeitia, Blitsas, & Carreiras, 2009); Russian (Tsaparina, Bonin & Méot, 2011); Persian (Bakhtiar, Nilipour, & Weekes, 2013) and Turkish (Raman, 2011; Raman et al, 2014).

One question raised in this field, also addressed in this thesis, is in relation to the extent to which a reader has strategic control over processes in visual word recognition (see Chapter 4 for details). Frederiksen and Kroll's (1976) were the first to experimentally investigate the influence of stimuli type in experimental blocks, i.e. list or context effects, on RTs in naming. Frederiksen and Kroll (1976) proposed that if the lexical route is used to name words and the nonlexical route is used to name nonwords (as discussed in Chapter 3), naming RTs should be different and determined by list type It was reported that RTs in the pure-block condition were faster than the mixed condition even for nonwords. The systematic differences observed in the pure vs. mixed-blocks were attributed to possible changes in strategies, i.e. lexical vs. nonlexical, a reader may adopt under task demands (see Lupker, Brown and Colombo, 1997 for a review on context effects). Studies on other languages such as Persian (Baluch and Besner, 1991) and Turkish (Raman, Baluch and Besner, 2004) have also yielded similar results.

Although research on AoA has flourished in the past 20 years with evidence in favour of the AoA effect from a diverse range of orthographies reported in Chapter 7, little has been done since the initial query regarding the influence of AoA on free recall by Morris (1981). Because of its unique lexico-semantic properties which are assumed to reside in the semantic system (Brysbaert et al, 2000), and also organised according to the chronological entry point to the mental lexicon, AoA provides an ideal medium to test its role on memory. In this respect, Ghyselinck (2002) states that '*… the study of visual word processes has provided a framework in which to explore many different mental processes like perception, learning, memory, thought, and knowledge representation*'.

Morris (1981) is credited to be the first to examine how AoA influences free recall in English. Using a list of early and late words mixed together Morris (1981) reported that late acquired words were better recalled than early acquired words. This finding is counterintuitive as early acquired items are expected to have stronger and earlier representations in memory, hence better recall. The study was replicated by Coltheart and Winograd (1986) in a pure list condition who reported no effect of AoA (see Chapter 4 for a review of list or context effects in experimental tasks). Dewhurst, Hitch and Barry (1998) combined the experimental methods used by Morris (1981) and Coltheart and Winograd (1986) in an experiment employing both a mixed list and pure list design. The authors also controlled for word frequency which is an additional issue for AoA research. In line with Morris' (1981) finding, Dewhurst et al (1998) also reported a significant main effect for AoA in in the mixed list only. Participants recalled more late acquired than early acquired words and more words of low than high frequency words. The results were taken to indicate that AoA effect was a modifiable entity prone to context effects (i.e. list effects) and that late acquired words appeared to influence the encoding hence the retrieval of episodic memory differently (perhaps with stronger, more permanent semantic representations) than early acquired words. In the pure list condition, Dewhurst et al (1998) reported only a significant frequency effect. Participants were better at recalling high frequency words compared to low frequency words. AoA effect was nonsignificant in the pure list condition and no interaction between the two variables. Dewhurst et al concluded that '*Findings were attributed to the more distinctive encoding of low-frequency and late-acquired words*' (p284). Even if this supposition could be true for English, it is difficult to define, operationalise and manipulate '*distinctive encoding'* in other orthographies. In fact, Raman et al argued this point recently in relation to transparent Turkish (under review). One could argue that Russian words, however, are more similar to English than Turkish in terms of irregular representations between orthography and phonology – a form of distinctiveness. It remains to be seen whether AoA will be more influential in the recall of late acquired words compared to early acquired words in a mixed block condition in Russian as in English.

Until very recently, evidence of AoA effects on free recall had been limited to English (Morris, 1981; Coltheart and Winograd, 1986; Dewhurst et al's, 1998). In a partial replication of Dewhurst et al (1998), Raman et al (2015; under review) examined the role of AoA on free recall in Turkish and have reported contradictory findings to English. It appears that perhaps one of the reasons for such diverse findings is caused by the remarkable differences in relation to orthographic transparency between English and Turkish.

Recruiting monolingual Russian speakers, Experiment 10 was designed to explore whether AoA would have a role on free recall of pictures and their names (words) under pure versus mixed block conditions. Pure blocks consisted of either early or late items only while mixed blocks consisted of early and late items randomly mixed together. The results were interesting and contrary to those reported in English as a significant main effect was found for both word and picture recall for AoA. There was no interaction between list type and stimuli type either. The pattern of results reported here are in line with those reported in Turkish (Raman, et al, 2015; under review). Word and picture processing are assumed to arise from different sources (see Paivio, 2007). While words are influenced by the nature of language/orthography which in turn influences processing, i.e. language dependent, pictures are immune to the nature of orthography, i.e. orthography independent. In this respect, it is rather puzzling to see that the recall of early and late acquired Russian words, a distinct and opaque orthography, would yield similar results to transparent Turkish. When the predictions of the semantic hypothesis for AoA effects are considered, that is, that processing will be faster and more accurate for early acquired words because they are assumed to enter the representational system first, it follows to interpret the findings within this framework. Moreover, results demonstrate a clear picture recall superiority effect irrespective of type of list and AoA.

Based on the findings from Experiments 1, it is concluded that the significant semantic priming effect reported for monolingual Russian speakers is in line with predictions of the semantic activation hypothesis and adds to the body of literature on this paradigm. The faster word naming RTs under the related compared to the unrelated condition is indicative of the activation of the semantic lexicon which speeds up the lexical route. Significant AoA results from Experiment 10 support the predictions of the semantic hypothesis (Brysbaert et al, 2000) for words and the picture superiority effect in free recall (Paivio, 1971; 2007). To the best knowledge of the author, these findings are reported for the first time in the literature shedding light onto understanding how lexico-semantic processes and memory are accessed in monolingual Russian speakers. Armed with this information the focus turns to bilingual Russian (L1) –English (L2) speakers.

How are the two languages of a bilingual organised?

The general consensus in the bilingual literature is that there are cognitive advantages associated with speaking two languages (Bialystok, 1994; 2001). One source for this advantage is assumed to be rooted in the necessity to manage two representational systems and use each one appropriately. This assumption has led to the following queries, the main aim of the current thesis:

i) how the two languages of a bilingual are organised or stored, that is, whether each language is stored in one or more locations in bilingual memory and

ii) how the two languages are processed, i.e. what mental capacities are required to process each language

As discussed in Chapter 3, the Revised Hierarchical Model (RHM; Kroll and Stewart, 1994) of bilingual language processing evolved from two previous accounts which only partially addressed the questions above. The RHM not only addresses the issue of organisation and storage of two representational systems, but it also takes into account the proficiency of the second language (L2). This is an important factor as discussed in detail under Chapter 2 because it has implications on both the organisation and the processing of the two languages. An important note here is that all Russian (L1)-English (L2) bilingual participants recruited for Experiments 2-9 and 11 scored a high level of proficiency on the Schonell test although they did not start learning English (L2) until 9 years of age on average.

Based on the recommendations in the current bilingual literature (for an overview see Altarriba and Basnight-Brown, 2007), semantic priming effect was examined in bilingual Russian (L1) –English (L2) speakers first under within-language condition in Experiments 2 and 3 followed by between-language conditions in Experiments 4 and 5 using the naming task. Taking into account Experiment 1 with monolinguals, three possible outcomes were predicted:

i) semantic priming effect will be the same for monolingual Russian (L1) and Russian (L1)-English (L2) bilinguals

ii) semantic priming effect will be smaller for Russian (L1)-English (L2) bilinguals compared to monolingual Russian (L1)

iii) semantic priming effect will be larger for Russian (L1)-English (L2) bilinguals compared to monolingual Russian (L1).

It therefore follows that if i) the size of semantic priming effect is the same for monolingual Russian (L1) and bilingual Russian (L1)-English (L2) speakers, it will be taken to indicate that having semantic networks (Collins and Quillian, 1969) in two different languages does not influence spreading activation (Collins and Loftus, 1975). If ii), then it will be assumed that nontarget language L2 is activated which has a negative influence on the semantic priming effect in the target language L1. If iii), this will be taken to indicate that although nontarget language L2 is activated, it has a positive or facilitatory effect on L1 semantic priming effect.

Subsequently, evidence for (i) would support a two-store model where L1 and L2 are stored in semantic networks independent of each other (e.g. Potter et al, 1984). Evidence for (ii) and (iii) will be taken to indicate a common store (Paivio et al, 1988) as depicted in the RHM by Kroll and Stewart (1994), one memory store for concepts for both languages.

The magnitude of the semantic priming effect in Experiment 1 for monolinguals was smaller (25ms) compared to within-language (L1-L1) in Experiment 2 (50ms) and (L2-L2) in Experiment 3 (46ms). For between-language conditions, the magnitude of semantic priming was similar in (L1-L2) Experiment 4 (21ms) and in (L2-L1) Experiment 5 (22ms). Based on the predictions above, these findings are in strong support of position (iii), namely one memory store for concepts for both languages as depicted in the RHM by Kroll and Stewart (1994). The significant priming effect in English (L2) was also significantly associated with L2 proficiency confirming its contribution to the activation of semantic networks in bilingual memory.

Having established a theoretical understanding of how the two languages are stored in Russian (L1)-English (L2) bilinguals, the next set of experiments addressed the issue of how the two orthographic representations influence bilingual processes. Experiments 6-9 exploited the unique and shared properties of Russian and English orthographies to create letter strings that were either transcribed in language congruent (i.e. L1/O1 and L2/O2) or incongruent (i.e. L1/O2 Russian word written in English and L2/O1 English word written in Cyrillic) conditions for both primes and targets. In effect, target words transcribed in the incongruent language condition can be considered as nonwords and were predicted to yield the smaller magnitude for semantic priming in comparison to target words that were transcribed in the congruent language although L2/O2 condition was predicted to yield a smaller effect in comparison to L1/O1 condition. Similarly, the impact of the incongruent prime versus the congruent prime condition was also expected to influence naming RTs and hence the magnitude of the effect. The pattern of results were interesting and showed that the smallest magnitude (1.4ms) for semantic priming in Experiment 7 (L1/O1 prime followed by L2/O1 target); followed by (13ms) Experiment 9 (L1/O2 prime followed by L2/O2 target); followed by (21.3ms) in Experiment 6 (L2/O1 prime followed by L1/O1 target) and finally by (27ms) Experiment 8 (L2/O2 prime followed by L1/O2 target). Seeing English words transcribed in Cyrillic produced the worst outcome. This can be explained within the dual route model of naming as the activation of the nonlexical route which is the only plausible way to name an unfamiliar letter string correctly (Coltheart, 1978; Besner, 1999). Therefore, the difference in RTs to naming related versus unrelated word-pairs is reduced because the activation of the nonlexical route overrides the activation of the lexico-semantic system. Interestingly, the results from Experiment 8 in which L2/O2 primes followed L1/O2 targets yielded the largest priming effect (27ms). One explanation of this unexpected effect is that with increasing use of computers and mobiles young Russians have become familiar with transcribing Russian words using only Roman letters. This also links with increased popularity of English as an additional language in Russia (Ustinova, 2005). To the best knowledge of the researcher, this is the first report that examined the role of orthographic manipulation under congruent and incongruent conditions in naming task on Russian (L1) – English (L2) bilinguals.

To conclude this section, the collective results of semantic priming Experiments 1-9 indicate to a common store for memory which is in line with the RHM (Kroll and Stewart, 1994) and to the existence of both lexico-semantic and nonlexical processes in Russian (L1) – English (L2) bilinguals.

Is bilingual memory organised according to AoA?

The next query in this thesis was to investigate the extent to which AoA shapes monolingual memory. It has been argued in the literature that as a psycholinguistic variable AoA resides within the semantic lexicon and thus closely related to the series of experiments reported earlier. The monolingual data in Experiment 10 showed a significant AoA effect and support the predictions of the semantic hypothesis (Brysbaert et al, 2000) for words and the picture superiority effect in free recall (Paivio, 1971; 2007). Experiment 11 was a replication of Experiment 10 but this time employed bilingual Russian (L1) – English (L2) speakers. For word recall, results showed a main effect for language but not for AoA; while post-hoc tests following a significant interaction between language and AoA found that while early AoA words were significantly better recalled in Russian (L1) than in English (L2) this was not the case for late AoA words. For pictures, main effects were found for both language and AoA. One interesting outcome was the null effect for list type. Despite this descriptive statistics showed that in English (L2) participants overall performed better in recalling words and pictures under the mixed list compared to the pure list condition especially for late items. Noteworthy is that when participants were required to recall items in Russian (L1) contrary results were found overall with only early items being better recalled under the mixed compared to the pure list condition.

Overall, these findings are in line with the experimental hypotheses which predicted that because L2 words enter into the bilinguals' lexicon later than L1, one cannot expect a comparable or same magnitude of AoA effect under these circumstances. Evidence from pictures show a robust AoA effect since picture processing is assumed to be language independent. These results are in line with the predictions of the semantic hypothesis (Brysbaert et al, 2000) and are taken to indicate the role of AoA in the ongoing construction of bilingual memory. It appears that even though there may not be L1 specific effects on free recall in L2, L2 speakers differ from monolinguals in terms of the semantic organization of their language processing system.

One of the additional goals of this thesis was to establish reliability between the AoA picture ratings from the current study with those reported in the literature. This also ensured that rating in Russian (L1) and English (L2) had comparable results between monolingual and bilingual participants. For monolingual participants, a significant relationship between the current ratings and Tsaparina et al's (2011) AoA norms were found. Moreover, a significant correlation was also found between the current ratings and those reported recently in a large normative study for 25 languages (Lumiewska et al, 2016). For bilingual participants significant correlations were also found in English (L2) AoA picture ratings between the current study and the English norms reported by Tsaparina et al (2011); the original Snodgrass and Vanderwart (1980) as well as Cortese and Khanna (2008). Therefore, the reliability of the items used in Experiments 10 and 11 were confidently established.

Conclusion

The conclusion based on evidence from the present thesis for Russian monolinguals and Russian (L1) – English (L2) bilinguals are as follows:

i) Semantic priming is a universal phenomenon across the range of languages including Russian. This finding is in line with the predictions of the semantic activation hypothesis and is reported in Russian for the first time.

ii) The idea that two languages of bilingual speaker are activated automatically via semantic activation was confirmed by finding that magnitude of semantic priming effect in Russian in bilinguals is larger than in monolinguals. Hence the assumption can be made that bilingualism positively contribute to lexico-semantic processing.

iii) The expectation that Russian (L1) – English (L2) bilinguals develop early and automatic between-language links at the semantic level was confirmed as predicted by the Revised Hierarchical Model.

iv) The findings from between-language word naming experiments showed that magnitude of the semantic priming effect is dependent on various factors such as L2 proficiency, and orthographic familiarity in population of Russian (L1) – English (L2) speakers.

v) The findings from free recall task are in line with suggestion of the presence of shared semantic representations in bilingual memory and the universality of the AoA effect across languages including Russian.

Limitations

Although the present study yields important findings in the fieled of monolingual and bilingual language processing nevertheless a number of limitations have to be acknowledged.

The main limitations are expressed as follows: the first limitations concern a sample size of the participants, particularly in the Experiments when the group of participants had to be divided by subgroups (e.g. 40 participants in Experiment 11 were allocated to conditions in Russian (L1) is as follows: 5 in pure word list and 6 in mixed word list; 5 in pure picture list and 5 in mixed picture list, and the rest were allocated to conditions in English (L2) is as follows: 5 in pure word list and 4 in mixed word list; 6 in pure picture list and 4 in mixed picture list). Increasing sample size would give greater power to detect differences between the conditions. However it is not within the scope of this study but increased number of participants balanced by gender would give an opportunity to analyse potential gender differences in monolingual and/or bilingual gender differences.

The current study was one of the few considering the role of L2 proficiency in the bilingual language processing. To fulfil this aim bilingual Russian (L1) – English (L2) speakers were assessed with Schonell Reading Test (1971) and only those candidates who showed good level of proficiency in English were asked to participate in word naming or free recall tasks. However, Schonell Reading Test being reliable and quick proficiency assessment tool but it does not take into an account comprehension skills of the reader. As an alternative reading test The Gray Oral Reading Test – Fifth Edition (GORT-5; Wiederholt & Bryant, 2012) can be used. The GORT-5 is an individually administered, norm- referenced assessment used to measure oral reading fluency and comprehension. It yields an Oral Reading Index composite score. Additionally, it includes a system for performing an analysis of reading errors or miscues. GORT-5 can be used for children and young adults up to 24 years old.

Future research may consider the improvement of the limitations mentioned above for detailed examining of monolingual and bilingual language processing, semantic activation and memory organization.

Future Directions

With a careful consideration of the quite extensive literature on the topic of lexico-semantic processing this thesis focused on examining how evidence from monolingual Russian speakers and bilingual Russian (L1) –English (L2) speakers could inform theories of visual word recognition, semantic activation and memory organisation. However, given the absence of comparable studies conducted in Russian monolinguals and Russian (L1) – English (L2) bilinguals, one of the main challenges in this thesis was the lack of psycholinguistic theoretical frameworks. The main contribution of this thesis is, therefore i) to report the first empirical findings on lexico-semantic processes and memory in monolingual Russian and bilinguals Russian (L1) – English speakers (L2) ii) to provide theoretical explanations for lexico-semantic processing and memory in Russian monolinguals and Russian (L1) – English (L2) bilinguals and ii) to propose new directions for research in Russian.

A plan for future research is to follow up AoA research which will include exploration of the AoA effect in single word naming tasks in order to evaluate whether there is a relationship between RTs and free-recall. This would help to fully account for the findings reported in Experiments 10 and 11.

Other recommendations for future research relate more specifically to the sample composition. For the purpose of this research programme, monolingual and bilingual participants were recruited from universities of approximately 17 to 25 years old. Future research would benefit from employing monolingual and bilingual speakers of different age range. This will give an opportunity to compare the AoA effects across different age groups and to explore if and how the organisation of monolingual and bilingual lexicon may change over the time in Russian speaking populations. Moreover, the development of age-appropriate normative data would be an additional venture in this domain.

The experimental methods used in the current research programme in order to investigate AoA effects in typical populations of monolingual Russian and bilingual Russian (L1) – English (L2) speakers can be applied to research in various neuropsychological groups. Indeed, evidence from monolingual groups of patients with Alzheimer's disease (Kremin et al., 2001; Silveri, Cappa, Mariotti and Puopolo, 2002), semantic dementia (Ralph, Graham, Ellis and Hodges, 1998), aphasia (e.g. Ellis, Lum and Lambon Ralph, 1996) and deep dyslexia (Barry and Gerhand, 2003) showed that early acquired words are more resistant to the effect of brain injury than late acquired words. Likewise, Nickels and Howard (1995) found AoA can significantly predict semantic errors in patients with aphasia. Although, recent normative data on action pictures and verbs has been published in Russian (Akinina et al, 2015), it is highly desirable to develop norms that specifically address impaired lexico-semantic processing in bilingual Russian (L1) – English (L2) speakers. Moreover, standardisation of the object and action naming battery developed by Druks and Masterson (2000) in Russian can be used for research and intervention purposes in neuropsychological cases.

In addition, the results of the current research programme can be used for further studies in the area of neurodevelopmental reading disorders, such as developmental dyslexia. In the study conducted in extremely transparent Turkish orthography adults with dyslexia showed a significant AoA effect in word and picture naming tasks similar to controls (Raman, 2011) as well as in other orthographies, for example in German (Wimmer and Mayringer, 2001), Finnish (Holopainen, Ahonen and Lyytinen, 2001), Italian (Brizzolara et al., 2006), and Spanish (Jimenez Gonzalez and Hernandez Valle, 2000) but has not been reported in dyslexia in Russian. Therefore the findings from the current research programme can be extended to the evaluation of AoA effect in naming and in free recall tasks in developmental dyslexia in monolingual Russian and bilingual Russian (L1) – English (L2) samples. Since lexical processing is assumed to be compromised in dyslexia due to phonological deficits as well as working memory problems (see Vellutino, Fletcher, Snowling and Scanlon, 2004 for a review), AoA could be pivotal to examine free recall.

Overall, the current thesis has both theoretical and empirical importance which may lead for further research endeavours and practical implications in the area of lexico-semantic processing in monolingual and bilingual normative and clinical Russian speaking population.

References

Abu-Rabia, S. (2001). Testing the interdependence hypothesis among native adult bilingual Russian-English students. *Journal of Psycholinguistic Research*, *30*(4), 437-455.

Akamatsu, N. (1999). The effects of first language orthographic features on word recognition processing in English as a second language. *Reading and Writing,* 11(4), 381-403.

Akinina, Y., Malyutina, S., Ivanova, M., Iskra, E., Mannova, E., & Dragoy, O. (2015). Russian normative data for 375 action pictures and verbs. *Behavior research methods*, 47(3), 691-707.

Alario, F.-X., & Ferrand, L. (1999). A set of 400 pictures standardized for French: Norms for name agreement, image agreement, familiarity, visual complexity, image variability, and age of acquisition. *Behavior Research Methods, Instruments, & Computers*, 31, 531–552.

Allport, D. A. (1977). On knowing the meaning of words we are unable to report: The effects of visual masking. *Attention and performance* VI, 505-533.

Altarriba, J. (1992). The representation of translation equivalents in bilingual memory. *Advances in psychology*, *83*, 157-174.

Altarriba, J., & Basnight-Brown, D. M. (2007). Methodological considerations in performing semantic-and translation-priming experiments across languages.*Behavior Research Methods*, *39*(1), 1-18.

Altarriba, J., & Bauer, L. M. (2004). The distinctiveness of emotion concepts: A comparison between emotion, abstract, and concrete words. *The American journal of psychology*, 389-410.

Altarriba, J. & Mathis, K. E. (1997). Conceptual and lexical development in second language acquisition. *Journal of Memory and Language, 36, 550-568.*

An, X. H., & Wang, D. M. (2013). Bilingual Education in the Context of China. A Review and Its Implication. *Sino-US English Teaching, 10*(2), 131-136.

Andrews, M., Vigliocco, G., & Vinson, D. (2009). Integrating experiential and distributional data to learn semantic representations. *Psychological Review, 116*, 463-498.

Baayen, H., Piepenbrock, R. & van Rijn, H. (1993). The CELEX database on CD-ROM. *Linguistic Data Consortium. Philadelpha, PA*.

Balota, D. A., Cortese, M. J., Sergent-Marshall, S. D., Spieler, D. H., & Yap, M. J. (2004). Visual word recognition of single-syllable words. Journal of Experimental Psychology: General, 133, 283-316.

Baluch, B., & Besner, D. (1991). Visual word recognition: Evidence for strategic control of lexical and non-lexical routines in oral reading. *Journal of Experimental Psychology: Learning, Memory and Cognition,* 17, 644-652

Barca, L., Burani, C., & Arduino, L. S. (2002). Word naming times and psycholinguistic norms for Italian nouns. *Behavior Research Methods, Instruments, & Computers*, *34*(3), 424-434.

Barhudarov, S.E., Dosycheva, E. I. (1940). Грамматика русского языка. Часть первая. Фонетика и морфология. [Russian grammar. Part one. Phonetics and morphology]. *State Educational and Pedagogical Publishing, Moscow.*

Barry, C., & Gerhand, S. (2003). Both concreteness and age-of-acquisition affect reading accuracy but only concreteness affects comprehension in a deep dyslexic patient. *Brain and Language,* 84(1), 84-104.

Barry, C., Hirsh, K. W., Johnston, R. A., & Williams, C. L. (2001). Age of acquisition, word frequency, and the locus of repetition priming of picture naming. *Journal of memory and language,* 44(3), 350-375.

Barry, C., Morrison, C. M., & Ellis, A. W. (1997). Naming the Snodgrass and Vanderwart pictures: Effects of age of acquisition, frequency, and name agreement. *The Quarterly Journal of Experimental Psychology: Section A*, *50*(3), 560-585.

Basnight-Brown, D. M., & Altarriba, J. (2007). Methodological considerations in performing semantic-and translation-priming experiments across languages.

Bates, E., Burani, C., D'Amico, S., & Barca, L. (2001). Word reading and picture naming in Italian. Memory & Cognition, 29(7), 986-999.

Beauvillain, C. (1992). Orthographic and lexical constraints in bilingual word recognition. In R. J. Harris (ed.), Cognitive processing in bilinguals, pp. 221–235. Amsterdam: Elsevier.

Beauvillain, C. & Grainger, J. (1987). Accessing interlexical homographs: Some limitations of a language-selective access. Journal of Memory and Language, 26, 658–672.

Behne, P. (1994). Simultaneous acquisition of German and English: Experiences and retrospective views of bilingualism by parents of bilinguals in Berlin. *Unpublished MA thesis, Frei Universitat, Berlin*.

Belke, E., Brysbaert, M., Meyer, A. S., & Ghyselinck, M. (2005). Age of acquisition effects in picture naming: evidence for a lexical-semantic competition hypothesis. *Cognition*, *96*(2), B45-B54.

Besner, D. (1999). Basic Processes in Reading: Multiple. *Converging methods for understanding reading and dyslexia,* 413.

Besner, D., Smith, M. C. (1992). Basic processes in reading: Is the orthographic depth hypothesis sinking? In R. Frost & L. Katz (Eds.), Orthography phonology morphology and meaning. *Advances in psychology,* Vol 94 (pp. 45-66). North-Holland, Oxford, England.

Bialystok, E. (2001).Metalinguistic aspects of bilingual processing. *Annual Review of Applied Linguistics*, *21*, 169-181.

Bialystok, E., & Hakuta, K. (1994). *In other words: The science and psychology of second-language acquisition*. Basic Books.

Biederman, I., Cooper, E. (1992). Size Invariance in Visual Object Priming. Journal of Experimental Psychology: Human Perception and Performance. 18 (1): 121–133. doi:10.1037/0096-1523.18.1.121.

Bijeljac-Babic, R., Biardeau, A. & Grainger, J. (1997). Masked orthographic priming in bilingual word recognition. Memory & Cognition, 25, 447–457.

Brizzolara, D., Chilosi, A., Cipriani, P., Di Filippo, G., Gasperini, F., Mazzotti, S., ... & Zoccolotti, P. (2006). Do phonologic and rapid automatized naming deficits differentially affect dyslexic children with and without a history of language delay? A study of Italian dyslexic children. *Cognitive and Behavioral Neurology,* 19(3), 141-149.

Blosfeld, M. E., & Bradley, D. C. (1981). Visual and auditory word recognition: Effects of frequency and syllabicity. *In third Australian Language and Speech conference,* Melbourne.

Boles, D. B., Rogers, S., & Wymer, W. (1982). Age of acquisition and visual field asymmetry in word recognition. *Attention, Perception, & Psychophysics*, *32*(5), 486-490.

Bonin, P., Barry, C., Méot, A., & Chalard, M. (2004). The influence of age of acquisition in word reading and other tasks: A never ending story?. *Journal of Memory and language*, *50*(4), 456-476.

Bonin, P., Chalard, M., Méot, A., & Barry, C. (2006). Are age-of-acquisition effects on object naming due simply to differences in object recognition? *Comments on Levelt (2002). Memory & cognition,* 34(5), 1172-1182.

Bonin, P., Chalard, M., Méot, A., & Fayol, M. (2002). The determinants of spoken and written picture naming latencies. *British Journal of Psychology*, *93*(1), 89-114.

Bonin, P., Fayol, M., & Chalard, M. (2001). Age of acquisition and word frequency in written picture naming. *The Quarterly Journal of Experimental Psychology: Section A*, *54*(2), 469-489.

Borenstein, E., & Ullman, S. (2008). Combined top-down/bottom-up segmentation. *Transactions on pattern analysis and machine intelligence*, 30(12), 2109-2125.

Boyden J.G., & Gilpin A.R. (1978).Matching familiar figures test and Stroop test performance in adults. *Perceptual and Motor Skills.* 46:854–858.

Bril, A., & Green, R. (2013). Bilingual Stroop in English Speakers with Russian as a Second Language: Exploring the Model of the Bilingual Mind. *FIVE: The Claremont Colleges Journal of Undergraduate Academic Writing*, *2*(1), 3.

Brown, G. D., & Watson, F. L. (1987).First in, first out: Word learning age and spoken word frequency as predictors of word familiarity and word naming latency. *Memory & Cognition*, *15*(3), 208-216.

Brysbaert, M., & Ghyselinck, M. (2006). The effect of age of acquisition: Partly frequency related, partly frequency independent. *Visual Cognition*, *13*(7-8), 992-1011.

Brysbaert, M., Ameel, E., & Storms, G. (2014). Bilingual Semantic Memory: A New Hypothesis. In *Foundations of Bilingual Memory* (pp. 133-146). Springer New York.

Brysbaert, M., G. Van Dyck, & M. Van de Poel (1999). Visual word recognition in bilinguals: evidence from masked phonological priming. *Journal of Experimental Psychology: Human Perception and Performance* 25. 137-48.

Brysbaert, M., Van Wijnendaele, I., & De Deyne, S. (2000). Age-of-acquisition effects in semantic processing tasks. *Acta Psychologica*, *104*(2), 215-226.

Carroll, J. B., & White, M. N. (1973). Word frequency and age of acquisition as determiners of picture-naming latency. *The Quarterly Journal of Experimental Psychology*, *25*(1), 85-95.

Cattell, J. M. (1947). On the time required for recognizing and naming letters and words, pictures and colors. *James McKeen Cattell: Man of science*, *1*, 13-25. Lnacaster, PA: Science Press. [Originally published 1888].

Cattell, J. M. (1888). The psychological laboratory at Leipsic. Mind, (49), 37-51.

Cavanagh, P., Wilson, R. A., & Keil, F. C. (1999). Top-down processing in vision. *MIT Encyclopedia of Cognitive Science.*

Chen, H. C., & Ng, M. L. (1989). Semantic facilitation and translation priming effects in Chinese-English bilinguals. *Memory & Cognition*, *17*(4), 454-462.

Chen, H.C. & Ho, C. (1986).Development of stroop interference in Chinese-English bilinguals. Journal of Experimental Psychology: Learning, Memory & Cognition, 12, 397–401.

Cohen J.D., Dunbar K., McClelland J.L. (1990). On the control of automatic processes: A parallel distributed processing account of the Stroop effect. *Psychological Review*. 97:332–361.

Collins, A. M., & Loftus, E. F. (1975). A spreading-activation theory of semantic processing. *Psychological review*, *82*(6), 407.

Collins, A. M., & Quillian, M. R. (1969). Retrieval time from semantic memory. *Journal of verbal learning and verbal behavior*, *8*(2), 240-247.

Coltheart, M. (1978). Lexical access in simple reading tasks. Strategies of Information Processing, ed. by G. Underwood, 151-216.

Coltheart, M., Curtis, B., Atkins, P., & Haller, M. (1993). Models of reading aloud: Dual-route and parallel-distributed-processing approaches. *Psychological review,* 100(4), 589.

Coltheart, M., Davelaar, E., Jonasson, T., & Besner, D. (1977). Access to the internal lexicon. In S. Dornic (Ed.), *Attention and Perfomance,* (Vol.6), Hillsdale. NJ: Erlbaum.

Coltheart, M., & Rastle, K. (1994). Serial processing in reading aloud: Evidence for dual-route models of reading. *Journal of Experimental Psychology: human perception and performance,* 20(6), 1197.

Coltheart, V., Laxon, V. J., & Keating, C. (1988). Effects of word imageability and age of acquisition on children's reading. *British journal of psychology*, *79*(1), 1-12.

Coltheart, V., & Winograd, E. (1986). Word imagery but not age of acquisition affects episodic memory. *Memory & cognition*, *14*(2), 174-180.

Cortese, M. J., & Khanna, M. M. (2007). Age of acquisition predicts naming and lexical-decision performance above and beyond 22 other predictor variables: An analysis of 2,342 words. *The Quarterly Journal of Experimental Psychology*,*60*(8), 1072-1082.

Cortese, M. J., & Khanna, M. M. (2008). Age of acquisition ratings for 3,000 monosyllabic words. *Behavior Research Methods,* 40(3), 791-794.

Costa A., Albareda B., Santesteban M. (2008). Assessing the presence of lexical competition across languages: Evidence from the Stroop task. *Bilingualism: Language and Cognition.*11(2):121–131.

Coulmas, F. (1996). The inequality of languages: Economic aspects of language estimation. *Contributions to the sociology of language*, 71, 213-228.

Crystal, D. (2008). Two thousand million? *English Today,* 24(01), 3-6.

Cubberley, P. (2002). Russian: A linguistic introduction. *Cambridge, MA: Cambridge University Press.*

Cuetos, F., Ellis, A. W., & Alvarez, B. (1999). Naming times for the Snodgrass and Vanderwart pictures in Spanish. *Behavior Research Methods, Instruments, & Computers*, 31(4), 650-658.

Dehaene, S., Naccache, L., LeClec'h, G., Koechlin, E., Mueller, M., Dehaene-Lambertz, G., et al. (1998). Imaging unconscious semantic priming. *Nature,* 395, 597–600.

de Groot, A. & Nas, G. (1991). Lexical representation of cognates and noncognates in compound bilinguals. Journal of Memory and Language, 30, 90–123.

de Groot, A. M. (2011). Language and cognition in bilinguals and multilinguals: An introduction. New York, NY, US*: Psychology Press*.

de Groot, A. M. B. (1995). Determinants of bilingual lexicosemantic organization. Computer Assisted Language Learning, 8, 151–180.

de Groot, A. M. (1993). Word-type effects in bilingual processing tasks: Support for a mixed-representational system. In R. Schreuder & B. Weltens (eds.), The bilingual lexicon, pp. 27–52. Amsterdam: John Benjamins.

de Groot, A. M. (1992). Determinants of word translation. Journal of Experimental Psychology: Learning, Memory, and Cognition, 18, 1001–1018.

de Groot, A. M., Dannenburg, L., & Vanhell, J. G. (1994). Forward and backward word translation by bilinguals. *Journal of memory and language*, *33*(5), 600-629.

de Groot, A. M., Delmaar, P., & Lupker, S. J. (2000). The processing of interlexical homographs in translation recognition and lexical decision: Support for non-selective access to bilingual memory. *The Quarterly Journal of Experimental Psychology: Section A*, *53*(2), 397-428.

de Groot, A. M., & Kroll, J. F. (Eds.). (2014). Tutorials in bilingualism: Psycholinguistic perspectives. *Psychology Press.*

de Groot, A. M., & Nas, G. L. (1991). Lexical representation of cognates and noncognates in compound bilinguals. *Journal of memory and language*, *30*(1), 90-123.

de Houwer, A. (1999). Two or more languages in early childhood: some general points and practical recommendations*. Eric Digest*.

DeLosh, E. L., & McDaniel, M. A. (1996). The role of order information in free recall: Application to the word-frequency effect. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* 22(5), 1136.

Desmet, T., & Duyck, W. (2007). Bilingual language processing. *Language and linguistics compass*, *1*(3), 168-194.

Dewhurst, S. A., Hitch, G. J., & Barry, C. (1998). Separate effects of word frequency and age of acquisition in recognition and recall. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *24*(2), 284.

Dewhurst, S. A., & Robinson, C. A. (2004). False memories in children: Evidence for a shift from phonological to semantic associations. *Psychological Science,* 15(11), 782-786.

Dijksta, T. (2005). Bilingual visual word recognition and lexical access. *Handbook of bilingualism psycholinguistic approaches*, 54, 179-201.

Dijkstra, T., Grainger, J., & Van Heuven, W. J. (1999). Recognition of cognates and interlingual homographs: The neglected role of phonology. *Journal of Memory and language,* 41(4), 496-518.

Dijkstra, T., & Van Heuven, W. J. (2002). The architecture of the bilingual word recognition system: From identification to decision. *Bilingualism: Language and cognition*, *5*(03), 175-197.

Dijkstra, T., Van Jaarsveld, H., & Brinke, S. T. (1998). Interlingual homograph recognition: Effects of task demands and language intermixing. *Bilingualism: Language and Cognition*, *1*(01), 51-66.

Dimitropoulou, M., Duñabeitia, J. A., Blitsas, P., & Carreiras, M. (2009). A standardized set of 260 pictures for Modern Greek: Norms for name agreement, age of acquisition, and visual complexity. *Behavior Research Methods*, 41, 584–589.

Druks J. and Masterson J. (2000). An Object and Action Naming Battery. *Hove: Psychology Press*

Dupoux, E., & Mehler, J. (1990). Monitoring the lexicon with normal and compressed speech: Frequency effects and the prelexical code. *Journal of Memory and Language*, 29(3), 316-335.

Durgunoglu, A. & Roediger, H. L. (1987). Test differences in accessing bilingual memory. Journal of Memory and Language, 26, 377–391.

Duyck, W. (2005). Translation and associative priming with cross-lingual pseudohomophones: evidence for nonselective phonological activation in bilinguals. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *31*(6), 1340.

Duyck, W., & Brysbaert, M. (2004). Forward and backward number translation requires conceptual mediation in both balanced and unbalanced bilinguals. *Journal of Experimental Psychology: Human Perception and Performance*, *30*(5), 889.

Dyer F. (1971) Color-naming interference in monolinguals and bilinguals. *Journal of Verbal Learning and Verbal Behavior.* 10(3):297–302.

Egorov, T. G. (2006). Психология овладения навыком чтения [The psychology of reading acquisition]. *St. Petersburg: KARO.*

Ellis, N. C. (2002). Frequency effects in language processing. *Studies in second language acquisition,* 24(02), 143-188.

Ellis, A. W., Burani, C., Izura, C., Bromiley, A., & Venneri, A. (2006). Traces of vocabulary acquisition in the brain: Evidence from covert object naming. *NeuroImage,* 33(3), 958-968.

Ellis, A. W., & Lambon Ralph, M. A. (2000). Age of acquisition effects in adult lexical processing reflect loss of plasticity in maturing systems: insights from connectionist networks. Journal of Experimental Psychology: Learning, Memory, and Cognition, 26(5), 1103.

Ellis, A. W., Lum, C., & Ralph, M. A. L. (1996). On the use of regression techniques for the analysis of single case aphasic data. *Journal of Neurolinguistics*, 9(3), 165-174.

Ellis, A. W., & Marshall, J. C. (1978). Semantic errors or statistical flukes? a note on allport's "on knowing the meaning of words we are unable to report". *The Quarterly Journal of Experimental Psychology,* 30(3), 569-575.

Ellis, H. D., & Young, A. W. (1977). Age-of-acquisition and recognition of nouns presented in the left and right visual fields: A failed hypothesis. *Neuropsychologia*, *15*(6), 825-828.

Favreau, M., & Segalowitz, N. S. (1983). Automatic and controlled processes in the first-and second-language reading of fluent bilinguals. *Memory & Cognition*, *11*(6), 565-574.

Ferrand, L., New, B. (2003).: Semantic and associative priming in the mental lexicon, found on: boris.new.googlepages.com/Semantic-final-2003.pdf

Finkbeiner, M., Forster, K., Nicol, J., & Nakamura, K. (2004). The role of polysemy in masked semantic and translation priming. *Journal of Memory and Language*, *51*(1), 1-22.

Forster, K. I. (1998). The pros and cons of masked priming. *Journal of Psycholinguistic Research,* 27, 203–233.

Forster, K. I., & Chambers, S. M. (1973). Lexical access and naming time. *Journal of verbal learning and verbal behavior*, *12*(6), 627-635.

Forster, K. I., & Davis, C. (1984). Repetition priming and frequency attenuation in lexical access. *Journal of experimental psychology: Learning, Memory, and Cognition*, *10*(4), 680.

Forster, K. I., Mohan, K., & Hector, J. (2003). The mechanics of masked priming. In S. Kinoshita & S. J. Lupker (Eds.), *Masked priming: State of the art (pp. 3–37). Hove, UK: Psychology Press.*

Francis, W. S. (2005). Bilingual semantic and conceptual representation. *Handbook of bilingualism: Psycholinguistic approaches,* 251-267.

Francis, W. S. (1999). Cognitive integration of language and memory in bilinguals: semantic representation. *Psychological bulletin*, *125*(2), 193.

Frederiksen, J. R., & Kroll, J. F. (1976). Spelling and sound: Approaches to the internal lexicon. Journal of Experimental Psychology: *Human Perception and Performance*, 2(3), 361.

Frenck, C., & Pynte, J. (1987). Semantic representation and surface forms: A look at across-language priming in bilinguals. *Journal of Psycholinguistic Research*, *16*(4), 383-396.

Friedberg, M. (1997). *Literary translation in Russia: A cultural history*. Penn State Press.

Frost, R., Katz, L., & Bentin, S. (1987). Strategies for visual word recognition and orthographical depth: a multilingual comparison. *Journal of Experimental Psychology: Human Perception and Performance*, 13(1), 104.

Gerard, L. D., & Scarborough, D. L. (1989). Language-specific lexical access of homographs by bilinguals. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 15(2), 305.

Gathercole, S. E. (2006). Nonword repetition and word learning: The nature of the relationship. *Applied Psycholinguistics*, *27*(04), 513-543.

Gathercole, V. C. M., & Thomas, E. M. (2009). Bilingual first-language development: Dominant language takeover, threatened minority language take-up. *Bilingualism: Language and Cognition,* 12(02), 213-237.

Gerhand, S., & Barry, C. (1998). Word frequency effects in oral reading are not merely age-of-acquisition effects in disguise. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *24*(2), 267.

Gerhand, S., & Barry, C. (1999a). Age-of-acquisition and frequency effects in speeded word naming. *Cognition*, *73*(2), B27-B36.

Gerhand, S., & Barry, C. (1999b). Age of acquisition, word frequency, and the role of phonology in the lexical decision task. *Memory & Cognition*, *27*(4), 592-602.

Ghyselinck, M., Custers, R., & Brysbaert, M. (2004). The effect of age of acquisition in visual word processing: further evidence for the semantic hypothesis. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *30*(2), 550.

Gilhooly, K. J. (1984). Word age-of-acquisition and residence time in lexical memory as factors in word naming. *Current Psychology,* 3(2), 24-31.

Gilhooly, K. J., & Gilhooly, M. L. (1979). Age-of-acquisition effects in lexical and episodic memory tasks. *Memory & Cognition, 7,* 214-223.

Gilhooly, K. J., & Logie, R. H. (1980). Age-of-acquisition, imagery, concreteness, familiarity, and ambiguity measures for 1,944 words. *Behavior Research Methods & Instrumentation*, *12*(4), 395-427.

Gilhooly, K. J., & Logie, R. H. (1981). Word age-of-acquisition, reading latencies and auditory recognition. *Current Psychological Research*, *1*(3-4), 251-262.

Gilhooly, K. J., & Watson, F. L. (1981). Word age-of-acquisition effects: A review.*Current Psychological Reviews*, *1*(3), 269-286.

Gillund, G., & Shiffrin, R. M. (1984). A retrieval model for both recognition and recall. *Psychological review,* 91(1), 1.

Glanzer, M., & Duarte, A. (1971). Repetition between and within languages in free recall. *Journal of Verbal Learning and Verbal Behavior,* 10(6), 625-630.

Goodman, G. O., McClelland, J. L., & Gibbs, R. W. (1981). The role of syntactic context in word recognition. Memory & Cognition, 9(6), 580-586.

Gollan, T. H., Forster, K. I., & Frost, R. (1997). Translation priming with different scripts: Masked priming with cognates and noncognates in Hebrew-English bilinguals. *Journal of Experimental Psychology-Learning Memory and Cognition,* 23(5), 1122-1139.

Goldfarb L., & Tzelgov J. (2007). The cause of the within language Stroop Superiority Effect and its implications. *Quarterly Journal of Experimental Psychology*. 60:179–185.

Goswami, (2005). Chapter 28: Orthography, Phonology, and Reading Development: A Cross-Linguistic Perspective. in Malatesha, Joshi. *Handbook of orthography and literacy. Lawrence Erlbaum Assoc Inc.* pp. 463–464.

Graf, P., Mandler, G., & Haden P. (1982). Simulating amnesic symptoms in normal subjects. *Science, 218*, 1243-1244.

Grainger, J. (1993). Visual word recognition in bilinguals. In R. Schreuder & B. Weltens (eds.), The bilingual lexicon, pp. 11–26*. Amsterdam*: John Benjamins.

Grainger, J. (2008). Cracking the orthographic code: An introduction. *Language and Cognitive Processes,* 23, 1–35.

Grainger, J. & Dijkstra, A. (1992). On the representation and use of language information in bilinguals. In R. J. Harris (ed.), Cognitive rocessing in bilinguals, pp. 207–220. Amsterdam: Elsevier.

Grainger, J., & Beauvillain, C. (1988). Associative priming in bilinguals: Some limits of interlingual facilitation effects. *Canadian Journal of Psychology/Revue canadienne de psychologie*, *42*(3), 261.

Grainger, J., Midgley, K., & Holcomb, P.J. (2010). Re-thinking the bilingual interactive activation model from a developmental perspective (BIA-d). In M. Kail & M. Hickmann (Eds.), Language Acquisition across Linguistic and Cognitive Systems. New York: John Benjamins.

Green D.W. (1998). Mental control of the bilingual lexico-semantic system. *Bilingualism: Language and Cognition. 1*:67–81.

Gregg, V. H., Montgomery, D. C., & Castaño, D. (1980). Recall of common and uncommon words from pure and mixed lists. *Journal of Verbal Learning and Verbal Behavior*, 19(2), 240-245.

Grenoble L.A. (2012). The Encyclopedia of Applied Linguistics. Published Online: 5 NOV 2012. DOI: 10.1002/9781405198431.wbeal0716

Grigorenko, E.L. (2012). Влияние индивидуальных особенностей когнитивного развития на овладение навыками чтения и письма младшими школьниками [Influence of individual characteristics on cognitive development of reading and writing aqcusition of primary school pupils]. *Moscow State University named after Lomonosov Press, Department of Psychology.*

Grigorenko, E. L. (2010). *Report on the Russian Language for the world dyslexia forum*. Yale University, Columbia University, USA. Moscow State University, Russia.

Grigoreva, T.M. (2004). Три века русской орфографии (XVIII - XX вв.) [Three centuries of Russian Orthography (XVIII-XX]. *Moscow. Ellis Publishing House, 456.* ISBN 5-902872-03-0

Grosjean, F. (2001). The Bilingual's Language Modes. One Mind, two Languages: Bilingual Language Processing. J. Nicol. *Blackwell*, *1*, 1-22.

Grosjean, F. (1989). Neurolinguists, beware! The bilingual is not two monolinguals in one person. *Brain and language*, *36*(1), 3-15.

Grosjean, F. (1997a). The bilingual individual. *Interpreting*, *2*(1-2), 163-187.

Grosjean, F. (1997b). Processing mixed language: Issues, findings, and models. In A. de Groot & J. Kroll (eds.), Tutorials in bilingualism: Psycholinguistic perspectives, pp. 225–254. Hillsdale, NJ: Lawrence Erlbaum.

Grossi, G. (2006). Relatedness proportion effects on masked associative priming: An ERP study. Psychophysiology, 43,21–30.

Guasch, M., Sánchez-Casas, R., Ferré, P., & García-Albea, J. E. (2011). Effects of the degree of meaning similarity on cross-language semantic priming in highly proficient bilinguals. *Journal of Cognitive Psychology*, *23*(8), 942-961.

Harley, T. A. (2013). The psychology of language: From data to theory. *Psychology Press.*

Henderson, L. (1982). Orthography and word recognition in reading. *Academic Press.*

Holender, D. (1986). Semantic activation without conscious identification in dichotic listening, parafoveal vision, and visual masking: A survey and appraisal. *Behavioral and brain Sciences,* 9(01), 1-23.

Holmes, S. J., & Ellis, A. W. (2006). Age of acquisition and typicality effects in three object processing tasks. Visual Cognition, 13(7-8), 884-910.

Holopainen, L., Ahonen, T., & Lyytinen, H. (2001). Predicting delay in reading achievement in a highly transparent language. *Journal of learning disabilities*, 34(5), 401-413.

Huebler, F., & Lu, W. (2013). *Adult and Youth Literacy: National, Regional and Global Trends, 1985-2015*.

Hung, D. L., & Tzeng, O. J. (1981). Orthographic variations and visual information processing. Psychological Bulletin, 90(3), 377.

Iliev, I. G. (2013). Short History of the Cyrillic Alphabet. *International Journal of Russian Studies*, *2*(2), 1-65.

Ivanova, V.F, (1976). Современный русский язык. Графика и орфография. [Modern Russian Language. Graphics and spelling]. 2nd edition, Moscow. *Enlightment Publishing House, 288*.

Izura, C., & Ellis, A. W. (2002). Age of acquisition effects in word recognition and production in first and second languages. *Psicológica*, 23(2), 245-281.

Izura, C., & Ellis, A. W. (2004). Age of acquisition effects in translation judgement tasks. *Journal of Memory and Language*, *50*(2), 165-181.

Jacquet, M., & French, R. M. (2002). The BIA++: Extending the BIA+ to a dynamical distributed connectionist framework. Bilingualism: Language and Cognition, 5 (3), 202- 205.

Jared, D., & Kroll, J.F., (2001). Do bilinguals activate phonological representations in one or both of their languages when naming words? *Journal of Memory and Language* 44.2-31.

Jiang, N., & Forster, K. I. (2001). Cross-language priming asymmetries in lexical decision and episodic recognition. *Journal of Memory and Language*, *44*(1), 32-51.

Jiménez González, J. E., & Hernández Valle, I. (2000). Word identification and reading disorders in the Spanish language. *Journal of Learning disabilities*, 33(1), 44-60.

Jin, Y. S. (1990). Effects of concretness on cross-language priming in lexical decisions. *Perceptual and Motor Skills, 70, 1139-1154.*

Johnston, R. A., & Barry, C. (2006). Age of acquisition and lexical processing.*Visual Cognition*, *13*(7-8), 789-845.

Jorm, A. F. (1991). The validity of word age-of-acquisition ratings: A longitudinal study of a child's word knowledge. *British Journal of Developmental Psychology*,*9*(3), 437-444.

Juhasz, B. J. (2005). Age-of-acquisition effects in word and picture identification. *Psychological bulletin,* 131(5), 684.

Juhasz, B. J., & Rayner, K. (2006). The role of age of acquisition and word frequency in reading: Evidence from eye fixation durations. *Visual Cognition,* 13(7-8), 846-863.

Katz, L., & Frost, R. (1992). Reading in different orthographies: The orthographic depth hypothesis. In R. Frost & L. Katz (Eds.), *Orthography, phonology, morphology, and meaning* (pp. 67-84). Amsterdam: Elsevier.

Katz, L., & Feldman, L. B. (1983). Relation between pronunciation and recognition of printed words in deep and shallow orthographies. J*ournal of Experimental Psychology: Learning, Memory, and Cognition,* 9(1), 157.

Keatley, C. W., Spinks, J. A., & De Gelder, B. (1994). Asymmetrical cross-language priming effects. *Memory & cognition*, *22*(1), 70-84.

Keatley, C., & Gelder, B. D. (1992). The bilingual primed lexical decision task: Cross-language priming disappears with speeded responses. European Journal of Cognitive Psychology, 4(4), 273-292.

Kerek, E. & Niemi, P. (2009a). Russian orthography and learning to read. *Reading in a Foreign Language, Volume 21, No. 1.* ISSN 1539-0578 pp. 1–21

Kerek E. & Niemi P. (2009b). Learning to read in Russian: effects of orthographic complexity. *Journal of Research in Reading, Volume 32-2,* 157–179 ISSN 0141-0423 DOI: 10.1111/j.1467-9817.2008.01390.x

Keuleers, E., Diependaele, K., & Brysbaert, M. (2010). Practice effects in large-scale visual word recognition studies: A lexical decision study on 14,000 Dutch mono-and disyllabic words and nonwords. *Frontiers in Psychology*, *1*, 174.

Kerkhofs, R., Dijkstra, T., Chwilla, D. J., & De Bruijn, E. R. (2006). Testing a model for bilingual semantic priming with interlingual homographs: RT and N400 effects. *Brain research,* 1068(1), 170-183.

Kiger, J. I., & Glass, A. L. (1983). The facilitation of lexical decisions by a prime occurring after the target. *Memory & Cognition*, *11*(4), 356-365.

Kirsner, K., Brown, H. L., Abrol, S., Chadha, N. K., & Sharma, N. K. (1980). Bilingualism and lexical representation. *The Quarterly journal of experimental psychology*, *32*(4), 585-594.

Kirsner, K., Smith, M. C., Lockhart, R. S., King, M. L., & Jain, M. (1984). The bilingual lexicon: Language-specific units in an integrated network. *Journal of Verbal Learning and Verbal Behavior*, 23(4), 519-539.

Kolb & Whishaw: *Fundamentals of Human Neuropsychology* (2003), page 453-454, 457.

Kornev, A.N., Rakhlin, N., Grigorenko, E.L. (2010). Dyslexia From a Cross-Linguistic and Cross-Cultural Perspective:The Case of Russian and Russia. *Learning Disabilities: A Contemporary Journal 8(1), 41–69.*

Kornev, A. N. (2003). Нарушения чтения и письма у детей [Difficulties in reading and writing in children]. *St. Petersburg: Rech’*

Kornev, A. N. (1995). Дислексия и дисграфия у детей [Dyslexia and dysgraphia in children]. *St. Petersburg: MiM.*

Kotz, S. A., & Elston-Güttler, K. (2004). The role of proficiency on processing categorical and associative information in the L2 as revealed by reaction times and event-related brain potentials. *Journal of Neurolinguistics*, *17*(2), 215-235.

Kotz, S. A. (2001). Neurolinguistic evidence for bilingual language representation: a comparison of reaction times and event-related brain potentials. *Bilingualism: Language and Cognition*, *4*(02), 143-154.

Kouider, S., Dehaene, S., Jobert, A., & Le Bihan, D. (2007). Cerebral bases of subliminal and supraliminal priming during reading. *Cerebral Cortex,* 17(9), 2019-2029.

Kremin, H., Perrier, D., De Wilde, M., Dordain, M., Le Bayon, A., Gatignol, P., ... & Arabia, C. (2001). Factors predicting success in picture naming in Alzheimer's disease and primary progressive aphasia. *Brain and Cognition*, 46(1), 180-183.

Kresin, S. C., Bernard, C., Stone, G., & Polinsky, M. (1996). *The Russian Language in the Twentieth Century.*

Kroll, J. F., & Curley, J. (1988). Lexical memory in novice bilinguals: The role of concepts in retrieving second language words. *Practical aspects of memory*,*2*(389-395).

Kroll, J. F., & De Groot, A. (1997). Lexical and conceptual memory in the bilingual: Mapping form to meaning in two languages.

Kroll, J. F., & Sholl, A. (1992). Lexical and conceptual memory in fluent and nonfluent bilinguals. *Advances in psychology*, *83*, 191-204.

Kroll, J. F., & Stewart, E. (1994). Category interference in translation and picture naming: Evidence for asymmetric connections between bilingual memory representations. *Journal of memory and language*, *33*(2), 149-174.

Kroll, J. F., & Stewart, E. (1990). Concept mediation in bilingual translation.

Kroll, J. F., & Tokowicz, N. (2001). The Development of Conceptual Representation for Words in a Second Language.

Kroll, J. F., Van Hell, J. G., Tokowicz, N., & Green, D. W. (2010). The Revised Hierarchical Model: A critical review and assessment. *Bilingualism (Cambridge, England)*, *13*(3), 373.

Lambert, W. E., Ignatow, M., & Krauthamer, M. (1968). Bilingual organization in free recall. *Journal of Verbal Learning and Verbal Behavior,* 7(1), 207-214.

Larsen, J. D., Fritsch, T., & Grava, S. (1994). A Semantic Priming Test of Bilingual Language Storage and the Compound vs Coordinate Bilingual Distinction With Latvian-English Bilinguals. *Perceptual and motor skills*, *79*(1), 459-466.

Leopold W. F. (1953). Patterning in children's language learning. *Language Learning* 5 (1-2): 1–13.

Lewis, M. B., Chadwick, A. J., & Ellis, H. D. (2002). Exploring a neural-network account of age-of-acquisition effects using repetition priming of faces. *Memory & cognition,* 30(8), 1228-1237.

Lewis, M. B., Gerhand, S., & Ellis, H. D. (2001). Re-evaluating age-of-acquisition effects: are they simply cumulative-frequency effects?. *Cognition*, *78*(2), 189-205.

Li, P. (1996). Spoken word recognition of code-switched words by Chinese-English bilinguals. Journal of Memory and Language, 35, 757–774.

Liepmann, D., & Saegert, J. (1974). Language tagging in bilingual free recall. *Journal of Experimental Psychology*, 103(6), 1137.

Liu, Y., Shu, H., & Li, P. (2007). Word naming and psycholinguistic norms: Chinese. Behavior research methods, 39(2), 192-198.

Łuniewska, M., Haman, E., Armon-Lotem, S., Etenkowski, B., Southwood, F., Anđelković, D., ... & Gagarina, N. (2016). Ratings of age of acquisition of 299 words across 25 languages: Is there a cross-linguistic order of words? *Behavior research methods,* 48(3), 1154-1177.

Lyashevskaya, O., & Sharov, S. (2009). The frequency dictionary of modern Russian language. *Azbukovnik, Moscow*.

Lyons, J. (1968). *Introduction to theoretical linguistics*. Cambridge university press.

MacLeod, C. M. (1991). Half a century of research on the Stroop effect: an integrative review. *Psychological bulletin*, 109(2), 163.

MacLeod, C. M., & Kampe, K. E. (1996). Word frequency effects on recall, recognition, and word fragment completion tests. *Journal of experimental psychology learning memory and cognition,* 22, 132-142.

MacNevin, C., & Besner, D. (2002). When are morphemic and semantic priming observed in visual word recognition? *Canadian Journal of Experimental Psychology*, 56, 112-119.

Malt, B. C., Sloman, S. A., Gennari, S., Shi, M., & Wang, Y. (1999). Knowing versus naming: Similarity and the linguistic categorization of artifacts. *Journal of Memory and Language*, *40*(2), 230-262.

Marcel, A. J. (1983). Conscious and unconscious perception: Experiments on visual masking and word recognition. Cognitive psychology, 15(2), 197-237.

Marian, V., Blumenfeld, H. K., Mizrahi, E., Kania, U., & Cordes, A.-K. (2013). Multilingual Stroop performance: Effects of trilingualism and proficiency on inhibitory control. *International Journal of Multilingualism*, 10(1), 82–104.

Marslen-Wilson, W. D. (1987). Functional parallelism in spoken word-recognition. *Cognition,* 25(1), 71-102.

Masson, M. E., & Isaak, M. I. (1999). Masked priming of words and nonwords in a naming task: Further evidence for a nonlexical basis for priming. *Memory & Cognition*, 27(3), 399-412.

Matsukawa, J., Snodgrass, J., Doniger, G. (2005). "Conceptual versus perceptual priming in incomplete picture identification". *Journal of Psycholinguistic Research*. 34 (6).

Mayr, S. and Buchner, A. (2007). Negative Priming as a Memory Phenomenon: A Review of 20 Years of Negative Priming Research. *Journal of Psychology*. 215 (1): 35–51.

McArthur, T. (1998). Orthography. Concise Oxford Companion to the English Language. Retrieved January 23, 2015 from *Encyclopedia.com*: http://www.encyclopedia.com/doc/1O29-ORTHOGRAPHY.html

McClelland, J. L., & Rumelhart, D. E. (1981). An interactive activation model of context effects in letter perception: part 1. An account of basic findings. *Psychological Review*, 88 (5).

McCusker, L. X., Hillinger, M. L., & Bias, R. G. (1981). Phonological recoding and reading. *Psychological Bulletin,* 89(2), 217.

McNamara, T. P., & Holbrook, J. B. (2003). Semantic memory and priming.*Handbook of psychology*.

McRae, K., Jared, D., & Seidenberg, M. S. (1990). On the roles of frequency and lexical access in word naming. *Journal of Memory and Language*, *29*(1), 43-65.

Menenti, L., & Burani, C. (2007). What causes the effect of age of acquisition in lexical processing? *The Quarterly Journal of Experimental Psychology*, *60*(5), 652-660.

Meyer, D. E., & Schvaneveldt, R. W. (1971). Facilitation in recognizing pairs of words: evidence of a dependence between retrieval operations. *Journal of experimental psychology*, *90*(2), 227.

Monaghan, J., & Ellis, A. W. (2002a). Age of acquisition and the completeness of phonological representations. *Reading and Writing,* 15(7), 759-788.

Monaghan, J., & Ellis, A. W. (2002b). What exactly interacts with spelling--sound consistency in word naming?. Journal of Experimental Psychology: Learning, Memory, and Cognition, 28(1), 183.

Moon, J., & Jiang, N. (2012). Non-selective lexical access in different-script bilinguals. *Bilingualism: Language and Cognition* 15: 173–180.doi:10.1017/S1366728911000022

Morrison, C. M., Hirsh, K. W., Chappell, T., & Ellis, A. W. (2002). Age and age of acquisition: An evaluation of the cumulative frequency hypothesis. *European Journal of Cognitive Psychology*, *14*(4), 435-459.

Morrison, C. M., & Ellis, A. W. (2000). Real age of acquisition effects in word naming and lexical decision. *British Journal of Psychology*, *91*(2), 167-180.

Morrison, C. M., Chappell, T. D., & Ellis, A. W. (1997). Age of acquisition norms for a large set of object names and their relation to adult estimates and other variables. *The Quarterly Journal of Experimental Psychology: Section A*, *50*(3), 528-559.

Morrison, C. M., & Ellis, A. W. (1995). Roles of word frequency and age of acquisition in word naming and lexical decision. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *21*(1), 116.

Morrison, C. M., Ellis, A. W., & Quinlan, P. T. (1992). Age of acquisition, not word frequency, affects object naming, not object recognition. *Memory & Cognition*, *20*(6), 705-714.

Morris, P. E. (1981). Age of acquisition, imagery, recall, and the limitations of multiple-regression analysis. *Memory & Cognition*, *9*(3), 277-282.

Morton, J. (1980). The logogen model and orthographic structure. In U. Frith (Ed.), *Cognitive processes in spelling* (pp 117-133). London: Academic Press.

Morton, J. (1969). Interaction of information in word recognition. *Psychological Review*, 76, 165-178.

Nagy, W., Anderson, R. C., Schommer, M., Scott, J. A., & Stallman, A. C. (1989). Morphological families in the internal lexicon. *Reading Research Quarterly,* 262-282.

Nairne, J. S. (2010). Adaptive memory: Evolutionary constraints on remembering. In B. H. Ross (Ed.), *The psychology of learning and motivation* (Vol. 53, pp. 1–32). Burlington, VT: Academic Press.

Neely, J. H. (1991). Semantic priming effects in visual word recognition: A selective review of current findings and theories. *Basic processes in reading: Visual word recognition*, *11*, 264-336.

Neely, J. H. (1977). Semantic priming and retrieval from lexical memory: Roles of inhibitionless spreading activation and limited-capacity attention. *Journal of experimental psychology: general*, *106*(3), 226.

Neely, J. H., & Kahan, T. A. (2001). Is semantic activation automatic? A critical re-evaluation.

Nickels, L., & Howard, D. (1995). Aphasic naming: What matters?. *Neuropsychologia*, *33*(10), 1281-1303.

Niolaki, G. Z., Masterson, J., & Terzopoulos, A. R. (2014). Spelling improvement through letter-sound and whole-word training in two multilingual Greek-and English-speaking children*. Multilingual Education, 4(1), 1-23.*

Niolaki, G. Z., & Masterson, J. (2012). Transfer effects in spelling from transparent Greek to opaque English in seven-to-ten-year-old children. Bilingualism: Language and Cognition, 15(04), 757-770.

Nisi, M., Longoni, A. M., & Snodgrass, J. G. (2000). Italian measurement on the relation of name, familiarity, and acquisition age for the 260 figures of Snodgrass and Vanderwart. *Giornale Italiano di Psicologia*, 27, 205–218.

Nishimoto, T., Miyawaki, K., Ueda, T., Une, Y., & Takahashi, M. (2005). Japanese normative set of 359 pictures. *Behavior Research Methods,* 37, 398–416.

Paivio, A. (2007). *Mind and its evolution: A dual coding theoretical approach.* Mahwah, NJ: Erlbaum.

Paivio, A. (1971). *Imagery and verbal processes.* New York, NY: Holt, Rinehart & Winston.

Paivio, A., Clark, J. M., & Lambert, W. E. (1988). Bilingual dual-coding theory and semantic repetition effects on recall. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *14*(1), 163.

Paradis, M. (2009). Declarative and procedural determinants of second languages (Vol. 40). *John Benjamins Publishing*.

Paradis, J. (2010). Bilingual children's acquisition of English verb morphology: Effects of language exposure, structure complexity, and task type. *Language Learning*, 60(3), 651-680.

Peal E. & Lambert M. (1962). The relation of bilingualism to intelligence. *Psychological Monographs* 75 (546): 1–23.

Perani, D., Paulesu, E., Galles, N. S., Dupoux, E., Dehaene, S., Bettinardi, V., Mehler, J. (1998). The bilingual brain. Proficiency and age of acquisition of the second language. *Brain,* 121(10), 1841-1852.

Perea, M., Dunabeitia, J. A., & Carreiras, M. (2008). Masked associative/semantic priming effects across languages with highly proficient bilinguals. *Journal of Memory and Language*, *58*(4), 916-930.

Perea, M., & Gotor, A. (1997). Associative and semantic priming effects occur at very short stimulus-onset asynchronies in lexical decision and naming. *Cognition*,*62*(2), 223-240.

Pind, J., Jónsdóttir, H., Tryggvadóttir, H. B., & Jónsson, F. (2000). Icelandic norms for the Snodgrass and Vanderwart (1980) pictures: Name and image agreement, familiarity, and age of acquisition. *Scandinavian Journal of Psychology*, 41, 41–48.

Popova, M.V. & Kudryavceva, E.L. (2012). Русский как один из языков двуязычного ребенка: Методологические и методические аспекты. [Russian as a language of the bilingual child: Methodological and methodical aspects]. *Philology and Culture journal, 2.*

Posner, M. I., & Snyder, C. R. R. (1975). Information processing and cognition: the Loyola symposium.

Postman, L., & Keppel, G. (Eds.). (2014). *Norms of word association*. Academic Press.

Potter, M. C., So, K. F., Von Eckardt, B., & Feldman, L. B. (1984). Lexical and conceptual representation in beginning and proficient bilinguals. *Journal of verbal learning and verbal behavior*, *23*(1), 23-38.

Preston, M. S. & Lambert, W. E. (1969). Interlingual interference in a bilingual version of the Stroop color-word task. Journal of Verbal Learning and Verbal Behavior, 8, 295–301.

Protopapas, A., & Vlahou, E. L. (2009). A comparative quantitative analysis of Greek orthographic transparency. *Behavior Research Methods*, 41(4), 991-1008.

Pulvermüller, F. (2013). How neurons make meaning: brain mechanisms for embodied and abstract-symbolic semantics. *Trends in cognitive sciences*, 17(9), 458-470.

Ralph, M. A. L., Graham, K. S., Ellis, A. W., & Hodges, J. R. (1998). Naming in semantic dementia—what matters? *Neuropsychologia*, 36(8), 775-784.

Raman, I. (2011). The role of age of acquisition in picture and word naming in dyslexic adults. British Journal of Psychology, 102, 328–339.

Raman, I. (2006). On the age of acquisition effects in word naming and orthographic transparency: Mapping specific or universal? Visual Cognition, 13(7/8), 1044–1053.

Raman, I., Raman, E., Ikier, S., Kilecioglu, E., Uzun, D. & Zeyveli, S. (under review). Differential Effects of Age of Acquisition and Frequency on Memory: Evidence from Free Recall of Pictures and Words in Turkish.

Raman, I., Raman, E. & Mertan, B. (2014). A standardised set of 260 pictures for Turkish: Norms of name and image agreement, age of acquisition, visual complexity and conceptual familiarity. *Behavior Research Methods.* 46(2), pp588-595.

Raman, I., Baluch, B., & Besner, D. (2004). On the control of visual word recognition: Changing routes versus changing deadlines. *Memory & cognition,* 32(3), 489-500.

Raman, I., İkier, S., Raman, E., Kilecioğlu, E., Uzun, D., & Zeyveli, S. (2015). The role of age of acquisition and frequency on memory: evidence from free recall of pictures and words. Paper presented at the EPS Meeting, April 10, Leeds University.

Rajaram, S. (1996). Perceptual effects on remembering: Recollective processes in picture recognition memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* 22, 365–377.

Rastle, K., & Coltheart, M. (1999). Serial and strategic effects in reading aloud. *Journal of Experimental Psychology: Human perception and performance*, *25*(2), 482.

Reisberg, D. (1997). *Cognition: Exploring the science of the mind.* WW Norton & Co..

Roberts, S. G. (2013). *Evolutionary approach to bilingualism.* A Thesis submitted for the degree of Doctor of Philosophy School of Philosophy, Psychology and Language Sciences University of Edinburgh

Rochford, G., & Williams, M. (1962). Studies in the development and breakdown of the use of names: I. The relationship between nominal dysphasia and the acquisition of vocabulary in childhood. *Journal of Neurology, Neurosurgery & Psychiatry*.

Roelofs, A. (2009). Attention and Facilitation: Converging Information Versus Inadvertent Reading in Stroop Task Performance. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, Vol. 36, No. 2, 411–422

Rosselli, M., Ardila, A., Santisi, M. N., Arecco, M. D. R., Salvatierra, J., & Conde, A. (2002). Stroop effect in Spanish–English bilinguals. *Journal of the International Neuropsychological Society*, *8*(06), 819-827.

Rossion, B., & Pourtois, G. (2004). Revisiting Snodgrass and Vanderwart's object pictorial set: The role of surface detail in basic-level object recognition. *Perception,* 33(2), 217-236.

Rubenstein, H., Lewis, S. S., & Rubenstein, M. A. (1971). Evidence for phonemic recoding in visual word recognition. *Journal of Verbal Learning and Verbal Behavior*, *10*(6), 645-657.

Rubin, D. C. (1980). 51 properties of 125 words: A unit analysis of verbal behavior. *Journal of Verbal Learning and Verbal Behavior*, *19*(6), 736-755.

Sáchez-Casas, R. M., García-Albea, J. E., & Davis, C. W. (1992). Bilingual lexical processing: Exploring the cognate/non-cognate distinction. *European Journal of Cognitive Psychology*, *4*(4), 293-310.

Sanfeliù, M. C., & Fernandez, A. (1996). A set of 254 Snodgrass–Vanderwart pictures standardized for Spanish: Norms for name agreement, image agreement, familiarity, and visual complexity. *Behavior Research Methods, Instruments, & Computers*, 28, 537–555.

Sanchez-Casas, R., Ferre, P., Garcıa-Albea, J. E., & Guasch, M. (2006). The nature of semantic priming: Effects of the degree of semantic similarity between primes and targets in Spanish. *European Journal of Cognitive Psychology*, 18, 161_184.

Scarborough, D. L., Cortese, C., & Scarborough, H. S. (1977). Frequency and repetition effects in lexical memory. *Journal of Experimental Psychology: Human perception and performance*, 3(1), 1.

Scarborough, D. L., Gerard, L., & Cortese, C. (1984). Independence of lexical access in bilingual word recognition. *Journal of Verbal Learning and Verbal Behavior*, *23*(1), 84-99.

Schonell, F. J. (1971). *Reading and Spelling Tests.* Edinburgh: Oliver and Boyd.

Schoonbaert, S., Duyck, W., Brysbaert, M., & Hartsuiker, R. J. (2009). Semantic and translation priming from a first language to a second and back: Making sense of the findings. *Memory & Cognition*, *37*(5), 569-586.

Schreuder, R., & Baayen, R. H. (1997). How complex simplex words can be. *Journal of memory and language*, *37*(1), 118-139.

Schwanenflugel, P. J., & Rey, M. (1986a). Interlingual semantic facilitation: Evidence for a common representational system in the bilingual lexicon. *Journal of Memory and Language*, *25*(5), 605-618.

Schwanenflugel, P. J., & Rey, M. (1986b). The relationship between category typicality and concept familiarity: Evidence from Spanish-and English-speaking monolinguals. *Memory & Cognition*, *14*(2), 150-163.

Seidenberg, M. S., & McClelland, J. L. (1989). A distributed, developmental model of word recognition and naming. Psychological review, 96(4), 523.

Seidenberg, M. S., & Waters, G. S. (1989). Reading words aloud-a mega study.

Seidenberg, M. S., Waters, G. S., Sanders, M., & Langer, P. (1984). Pre-and postlexical loci of contextual effects on word recognition. *Memory & Cognition*,*12*(4), 315-328.

Shi, X. (2007). Intercultural Language Socialization: Theory and Methodology. *Intercultural Communication Studies*, *16*(1), 230.

Sholl, A., Sankaranarayanan, A., & Kroll, J. F. (1995). Transfer between picture naming and translation: A test of asymmetries in bilingual memory. *Psychological Science*, *6*(1), 45-49.

Silveri, M. C., Cappa, A., Mariotti, P., & Puopolo, M. (2002). Naming in patients with Alzheimer's disease: Influence of age of acquisition and categorical effects*. Journal of Clinical and Experimental Neuropsychology,* 24(6), 755-764.

Smith-Spark, J. H., Moore, V., & Valentine, T. (2013). Determinants of famous name processing speed: Age of acquisition versus semantic connectedness. *Acta psychologica*, *142*(2), 230-237.

Snodgrass, J. G., & Vanderwart, M. (1980). A standardized set of 260 pictures: norms for name agreement, image agreement, familiarity, and visual complexity*. Journal of experimental psychology: Human learning and memory*, 6(2), 174.

Snodgrass, J. G., & Yuditsky, T. (1996). Naming times for the Snodgrass and Vanderwart pictures. *Behavior Research Methods, Instruments, & Computers*, *28*(4), 516-536.

Skoyles, J. R. (1988). Vowels of civilization. New Scientist, 120 (1644/1645), 69-73

Spieler, D. H., & Balota, D. A. (1997). Bringing computational models of word naming down to the item level. *Psychological Science*, 411-416.

Stanovich, K., West, F. (1983). On Priming by a Sentence Context. *Journal of Experimental Psychology*. 112 (1): 1–36. doi:10.1037/0096-3445.112.1.1.

Steyvers, M., & Tenenbaum, J. B. (2005). The Large-scale structure of semantic networks: Statistical analyses and a model of semantic growth. *Cognitive science*, *29*(1), 41-78.

Stroop J.R. (1935). Studies in interference in serial verbal reactions. *Journal of Experimental Psychology.*18:643–661.

Sumiya, H., & Healy, A. F. (2004). Phonology in the bilingual Stroop effect. *Memory & cognition*, 32(5), 752-758.

Tabossi, P., & Laghi, L. (1992). Semantic priming in the pronunciation of words in two writing systems: Italian and English. *Memory & Cognition*, *20*(3), 303-313

Tanenhaus, M. K., & Lucas, M. M. (1987). Context effects in lexical processing. *Cognition*, *25*(1-2), 213-234.

Taylor, I., & Taylor, M. M. (1990). *Psycholinguistics: Learning and using language.* Englewood Cliffs, NJ: Prentice Hall International.

Therriault, D. J., Yaxley, R. H., & Zwaan, R. A. (2009). The role of color diagnosticity in object recognition and representation. *Cognitive Processes,* 10, 335–342.

Tkachev, R. A. (1933). Врождённая алексия [Inherited alexia]. *Soviet neuropathology, psychiatry and mental hygiene, 83-91.*

Tokowicz, N., Kroll, J. F., De Groot, A. M., & Van Hell, J. G. (2002). Number-of-translation norms for Dutch—English translation pairs: A new tool for examining language production. *Behavior Research Methods, Instruments, & Computers*,*34*(3), 435-451.

Treiman, R., Mullennix, J., Bijeljac-Babic, R., & Richmond-Welty, E. D. (1995). The special role of rimes in the description, use, and acquisition of English orthography. *Journal of Experimental Psychology: General*, *124*(2), 107.

Tulving, E., & Colotla, V. A. Free recall of bilingual lists. *Cognitive Psychology,* 1970, 1, 86–98.

Tsaparina, D., Bonin, P., & Méot, A. (2011). Russian norms for name agreement, image agreement for the colorized version of the Snodgrass and Vanderwart pictures and age of acquisition, conceptual familiarity, and imageability scores for modal object names. *Behavior Research Methods*, 43(4), 1085-1099.

Tzelgov, J., & Eben-Ezra, S. (1992). Components of the between-language semantic priming effect. *European Journal of Cognitive Psychology*, *4*(4), 253-272.

Tzelgov, J., Henik, A. & Leiser, D. (1990). Controlling Stroop interference: Evidence from a bilingual task. Journal of Experimental Psychology, 16, 760–771.

Urooj, U., Cornelissen, P. L., Simpson, M. I., Wheat, K. L., Woods, W., Barca, L., & Ellis, A. W. (2014). Interactions between visual and semantic processing during object recognition revealed by modulatory effects of age of acquisition. *Neuroimage*, *87*, 252-264.

Ustinova, I. P. (2005). English in Russia. *World Englishes*, 24(2), 239-252.

Vaidya, C., Monti, L., Gabrieli, J., Tinklenburg, J., Yesevage, J. (1999). Dissociation between two forms of conceptual priming in Alzheimer's disease. *Neuropsychology*. 13 (4): 516–24.

van Assche, E., Duyck, W., & Gollan, T. H. (2016). Linking recognition and production: Cross-modal transfer effects between picture naming and lexical decision during first and second language processing in bilinguals. *Journal of Memory and Language*, *89*, 37-54.

van Den Bosch, A., Content, A., Daelemans, W., & De Gelder, B. (1994). Analysing orthographic depth of different languages using data-oriented algorithms.

van Heuven W.J.B., Conklin K., Coderre E.L., Guo T., & Dijkstra T. (2011). The influence of cross-language similarity on within- and between-language Stroop effects in trilinguals. *Frontiers in Psychology*.2:1–15.

van Heuven, W.J.B., Dijkstra, T., (2010). Language comprehension in the bilingual brain: fMRI and ERP support for psycholinguistic models. *Brain Research Reviews* 64, 104–122

van Hell, J. G., & Dijkstra, T. (2002). Foreign language knowledge can influence native language performance in exclusively native contexts. *Psychonomic Bulletin & Review*, *9*(4), 780-789.

van Heuven, W. J. B., Dijkstra, T. & Grainger, J. (1998). Orthographic neighborhood effects in bilingual word recognition. Journal of Memory and Language, 39, 458–483.

Venezky, R. (1970). *The Structure of English orthography.* The Hague: Mouton.

Voga, M., & Grainger, J. (2007). Cognate status and cross-script translation priming. *Memory & Cognition, 35(5),* 938-952.

van Hell, J. G. & de Groot, A. M. B. (1998). Conceptual representation in bilingualmemory: Effects of concreteness and cognate status in word association. Bilingualism: Language and Cognition, 3, 193–211.

Wade, T. L. B. (1992). A comprehensive Russian grammar. *Oxford, UK: Blackwell*

Walley, A. C., & Metsala, J. L. (1990). The growth of lexical constraints on spoken word recognition. *Perception & Psychophysics*, *47*(3), 267-280.

Wang, M., Koda, K., & Perfetti, C. A. (2003). Alphabetic and nonalphabetic L1 effects in English word identification: A comparison of Korean and Chinese English L2 learners. Cognition, 87, 129–149.

Warren L.R., Marsh G.R. (1978). Hemispheric asymmetry in the processing of Stroop stimuli. *Bulletin of the Psychonomic Society.*12:214–216.

Watkins, M. J. & Peynircioglu, Z. F. (1983). On the nature of word recall: Evidence for linguistic specificity. Journal of Verbal Learning and Verbal Behavior, 22, 336–394.

Weber, G. (1997). Top Language. Language Monthly, (3).

Weekes, B. S., Shu, H., Hao, M., Liu, Y., & Tan, L. H. (2007). Predictors of timed picture naming in Chinese. *Behavior Research Methods,* 39, 335–342.

Wiederholt, J. L., & Bryant, B. R. (2012). Gray Oral Reading Test–Fifth Edition (GORT-5): Examiner's manual.

Williams, J. N. (1994). The relationship between word meanings in the first and second language: Evidence for a common, but restricted, semantic code. *European Journal of Cognitive Psychology*, *6*(2), 195-220.

Williams, P. C., & Parkin, A. J. (1980). On knowing the meaning of words we are unable to report confirmation of a guessing explanation. *Quarterly Journal of Experimental Psychology,* 32(1), 101-107.

Wilson, M. A., Ellis, A. W., & Burani, C. (2012). Age-of-acquisition affects word naming in Italian only when stress is irregular. *Acta psychologica,* 139(3), 417-424.

Wimmer, H., & Mayringer, H. (2001). Is the reading-rate problem of German dyslexic children caused by slow visual processes. *Dyslexia, fluency and the brain,* 116-133.

Woods C. (2006). Bilingualism, Scribal Learning, and the Death of Sumerian. In S. L. Sanders (ed) *Margins of Writing, Origins of Culture*: 91–120. Chicago.

Zevin, J. D., & Seidenberg, M. S. (2004). Age-of-acquisition effects in reading aloud: Tests of cumulative frequency and frequency trajectory. *Memory & Cognition*, *32*(1), 31-38.

Zevin, J. D., & Seidenberg, M. S. (2002). Age of acquisition effects in word reading and other tasks. *Journal of Memory and language*, *47*(1), 1-29.

Zied K.M., Phillipe A., Pinon K., Havet-Thomassin V., Ghislaine A., Roy A.R., Le Gall D. (2004). Bilingualism and adult differences in inhibitory mechanisms: Evidence from a bilingual stroop task. *Brain and Cognition*. 54(3):254–256.

Appendices